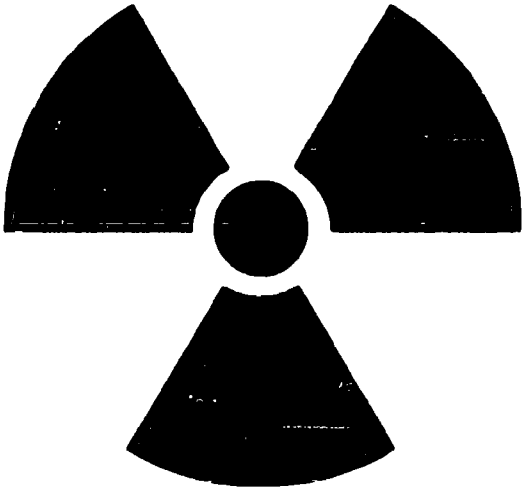
RADIOLOGICAL
SAFETY MANUAL



U.S. ARMY
BIOLOGICAL LABORATORIES
FREDERICK, MARYLAND

U.S. ARMY BIOLOGICAL LABORATORIES
Fort Detrick, Frederick, Maryland

RADIOLOGICAL SAFETY MANUAL

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FOREWORD

This manual has been published for the information, guidance, and compliance of all personnel engaged in the use, handling, storage, and/or disposal of radioactive material on this post. These Radiological Safety Regulations supersede that portion of the "General Biological, Chemical and Radiological Regulations" (January 1963) pertaining to radiological safety (part C, pages 30-36) and all other general regulations hitherto in force. They do not, however, supersede supplemental Building Radiological Safety Regulations unless the latter conflict with this manual.

The radiological regulations in "General Biological, Chemical and Radiological Safety Regulations" do not conflict with this manual but are in an abbreviated form and are for general information only.

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FIGURE

TABLES

I. GENERAL

1. REGULATIONS

This manual is issued by the Commanding Officer, U.S. Army Biological Laboratories, Fort Detrick, Frederick, Maryland. The regulations contained herein apply to all users of materials and equipment emitting ionizing radiations. These regulations meet the requirements of the following statutory codes and regulations:

a. The Atomic Energy Act of 1954 as published in Code of Federal Regulations: Title 10, Chapter I, Parts 20 and 30.

b. AR 40-414, AR 40-431, AR 40-580, AR 40-582, AR 385-10, AR 385-30, AR 385-40, and AR 755-380.

2. FORT DETRICK ISOTOPE COMMITTEE*

a. The Fort Detrick Isotope Committee is established to act in an advisory capacity to the Commanding Officer on all matters relating to the use, procurement, handling, storage, and disposal of radioactive materials at Fort Detrick. The Committee shall receive reports from the Radiological Safety Officer, U.S. Army Biological Laboratories, and review records, reports, and programs for conformity with the requirements of Title 10 of the Code of Federal Regulations and AR 40-580. The Committee shall perform the following functions:

(1) Review and approve, in advance of purchase, proposals for the use of radioisotopes at Fort Detrick.

(2) Review and make suggestions on special situations.

(3) Act for the Commanding Officer as the authoritative body on radiological safety rules and regulations.

(4) Exercise veto power by a majority vote over the policies of the Radiological Safety Officer.

(5) Operate through the Radiological Safety Section to accomplish its objectives in accordance with regulations of the Department of the Army and the U.S. Atomic Energy Commission.

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* Refer to Special Orders No. 177 dated 31 Oct 1961, No. 60 dated 25 Mar 1963, and No. 145 dated 18 July 1963.

(6) Exercise control over and disposal of machines that produce ionizing radiation and particles for other than diagnostic and therapeutic purposes.

b. The Committee members shall be appointed by the Commanding Officer and shall include the Radiological Safety Officer and others as prescribed in CFR 10, Part 30, paragraph 30.24 d.3.

3. RADIOLOGICAL SAFETY SECTION

The Fort Detrick Radiological Safety Section will perform the following functions:

a. Represent and act for the Commanding Officer, U.S. Army Biological Laboratories, on the Fort Detrick Isotope Committee on all radiological matters.

b. Represent the Commanding Officer, U.S. Army Biological Laboratories, on all Atomic Energy Commission licensing matters.

c. Serve as Radiological Protection Officer on the U.S. Army Biological Laboratories Atomic Energy Commission licenses.

d. Act for the Commanding Officer as staff coordinator in all matters pertaining to the storage, packaging, handling, shipping, and disposal of radioactive materials and waste.

e. Formulate and operate a radiological safety program to meet the requirements of Title 10 of the Code of Federal Regulations, Atomic Energy, and AR 40-580. He shall be responsible to the Fort Detrick Isotope Committee for performance of this function.

f. Review all radiological programs and operations at U.S. Army Biological Laboratories and ascertain that they comply with current regulations and requirements. Recommend appropriate action to the Fort Detrick Isotope Committee.

g. Act as an advisor and operational officer on radiological safety for the Fort Detrick Isotope Committee, maintaining necessary records pertaining to individual exposure records and inventories of radioactive material.

h. Direct the procurement of all radioactive materials and ionizing radiation-producing apparatus.

i. Receive and distribute all radioisotopes used at Fort Detrick.

j. Maintain current inventories of radioactive materials and ionizing equipment and their locations.

4. AREA SUPERVISORS

a. A Radiation Area Supervisor will be designated by the branch chief or other supervisor for each project involving the use of ionizing radiation (see Section II, paragraph 1). The Radiation Area Supervisor shall be organizationally in a position to be responsible for the over-all project and the actions of operational personnel.

b. The duties and responsibilities of the Radiation Area Supervisor are as follows:

(1) To supervise and ensure that day-to-day radiological safety practices are carried out by operational personnel within his project or area.

(2) To ensure that the rules and recommendations of the Radiological Safety Section are followed and that hazardous conditions are corrected as quickly as possible.

(3) To report immediately any fire, explosion, spill, theft, personnel overexposure, loss of control, or any other accident involving ionizing radiation within his area of responsibility to the Radiological Safety Office (See Section IV, paragraph 2).

(4) To receive and forward to operating personnel all results of routine radiation surveys prepared by the Radiological Safety Office, and to ensure that the recommendations of the survey are carried out.

(5) To ensure that his project is performed within the limits of the Radiological Program.

(6) To act in liaison between the individual operator and the Radiological Safety Office.

(7) To furnish information to the Radiological Safety Section concerning individuals and activities in their areas, especially additions or deletions from rosters or changes in location or laboratory size.

(8) To be responsible for biological decontamination of the film packets, where necessary, so as to facilitate "cold" area pickup by the Radiological Safety Section. Ethylene oxide (carboxiclave) is at present the only acceptable biological decontamination method for film badge dosimeters.

II. RADIOLOGICAL PROGRAMS, SURVEYS AND PROCUREMENT OF RADIOISOTOPES

1. RADIOLOGICAL PROGRAMS

a. Radioisotopes

(1) All operations involving the use of radioisotopes at U.S. Army Biological Laboratories will have an approved Radiological Program. Approval must be received prior to the beginning of any radiological operation or the procurement of radioisotopes and other sources of ionizing radiation with the exception of medical equipment. The program shall be submitted for approval to the Fort Detrick Isotope Committee, through Radiological Safety Office, on a Disposition Form, DA 2496, in triplicate, and will include the following information:

(a) The division or branch wishing to use or procure radioisotopes.

(b) The names of the Radiation Area Supervisor and all operational personnel.

(c) The radioisotope, its chemical and physical form, and the amount of activity (curies) to be used during the experiment as well as the total amount of activity to be on hand at any one time.

(d) A complete description of the proposed radiological operations to be performed. Whenever possible, do not include classified information unless the radiological operations cannot be described without such information.

(e) The location by building and room number or area in which the radiological operations are to be performed.

(f) A complete list of radiation monitoring and other equipment available for the proposed program (See Section III, paragraph 5 of this publication for further information).

(g) The radiation safety precautions (Section III) to be used in the proposed program.

(h) The signature of the division chief of the activity to which the requesting agency or branch is assigned.

(2) The radiological program will be approved on the basis of the SOP and the available equipment and facilities, as well as the radiation experience of the operating personnel and the responsible investigator.

(3) Appendix A is a sample Radiological Program that may be used as a guide. It should be noticed that the program includes a Comment 2 for the Fort Detrick Isotope Committee, certifying approval and assigning a number to the proposed program. Radiological operations shall not begin until the proposed program has been returned to the requesting agency with a Comment 3 granting approval for the program.

b. Accelerators, X-Ray, and Other Equipment that Produce Ionizing Radiation for Nonmedical Purposes.

(1) All operations involving the use of accelerators (Van de Graaff generators, cyclotrons, betatrons, etc.) X-ray machines, static eliminating devices, and other equipment that produce ionizing radiation will be approved by the Isotope Committee prior to their installation and operation. Approval will be given by means of a Radiological Program that shall be submitted to the Fort Detrick Isotope Committee, through Radiological Safety Section, in triplicate on DA Form 2496 and will describe the proposed operation, including the following information:

(a) The branch wishing to use the machine.

(b) The names of the Radiation Area Supervisor, responsible investigator, and all other operational personnel.

(c) The type of machine to be used, including the operating characteristics (voltage, amperage, filters, targets) as well as the manufacturer, model and serial number.

(d) A complete description of the operations to be performed. Do not include classified information unless the operations cannot be properly described without such information.

(e) The location, by building and room number, in which the machine is to be installed. A complete floor plan showing adjacent areas, proposed position of the machine, the console and shielding will be included.

(f) A complete list of radiation monitoring and other equipment available for the proposed test program (See Section III, paragraph 5 of this publication for further information).

(g) The radiation rules and precautions (Section III) to be used in the proposed test plan.

(h) The signature of the division chief of the activity to which the requesting agency or branch is assigned.

(2) The program will be approved on the basis of the available equipment and facilities, as well as the radiation experience of the operating personnel and the responsible investigator.

(3) The requesting agency shall not begin the described operations until the proposed plan has been approved and returned to the agency by the Isotope Committee.

2. SURVEYS OF RADIATION AREAS

a. Initial Survey

(1) It will often be necessary for Radiological Safety personnel to survey and approve sites and areas where radioisotopes or ionizing radiation-producing equipment or materials are to be used. The purpose of this survey is to insure that the facilities are adequate for the proposed test program. This is particularly true of laboratories or facilities that are not specifically designed for radiological operations. The survey will involve checking ventilation systems, filters, hoods, survey instruments available, waste disposal techniques, flooring materials, types of work benches, shielding, accessibility by unauthorized personnel, materials used for walls and ceilings and other pertinent matters.

(2) The initial survey will be made by the Radiological Safety Section prior to the approval of the proposed radiological program.

b. Routine Survey

(1) After the radiological test program is approved and operations have begun, the area or laboratory will be periodically surveyed by Radiological Safety personnel. These surveys will be made to determine whether:

(a) Proper shielding is being used and the maximum permissible radiation dosages are not being exceeded (Section III, paragraph 2)

(b) Contamination levels are maintained below those specified in Section III, paragraphs 3 and 4.

(c) The work is being conducted in accordance with this manual and with the approved Radiological Program covering the operation.

(2) Three copies of the findings of this survey will be prepared. The original and one carbon copy will be sent to the Radiation Area Supervisor, who will sign the original and return it to the Radiological Safety Section. The Area Supervisor will retain the carbon copy for his own records. The third carbon copy will be sent to the Post Surgeon.

c. Special Surveys

Special surveys are performed as needed during decontamination, spills, loss of control, or accidents involving radiation as well as during particularly hazardous radiological operations. These surveys and their results are recorded in a log book kept by the Radiological Safety Section. A written report of the findings of these surveys is given to the Radiation Area Supervisor.

3. RADIOLOGICAL SAFETY INSTRUCTION

The Radiological Safety Section will informally instruct operational personnel in the safety hazards and procedures for radiological operations. This instruction is available on request to all personnel actively assigned to radiological operations.

4. PROCUREMENT OF RADIOACTIVE MATERIAL

A proposed radiological program must be approved (see Section II, paragraph 1) before a request for procurement approval is made.

a. The procurement of all radioactive materials and machines capable of producing ionizing radiation will be accomplished only with the prior approval of the Radiological Safety Section. The materials and equipment mentioned above fall into four general categories with regard to procurement:

(1) Materials produced by or under the auspices of the Atomic Energy Commission and requiring an Atomic Energy Commission "Specific License."

(2) Materials procurable under an Atomic Energy Commission "General License."

(3) Other radioactive materials, which include primarily elements in the naturally radioactive series (radium, thorium, etc.).

(4) Apparatus and equipment capable of, or containing materials capable of, producing ionizing radiation. This includes X-ray machines, particle accelerators, certain cathode-ray tubes, electron microscopes, and many other devices.

b. The procurement of items in all four categories listed above will be initiated only with prior approval of the program description as described in Section II, 2, a. Information concerning the procedure for the procurement of items in the above categories is available from the Radiological Safety Section.

c. Radiological Safety Section will be notified immediately that a shipment arriving on post contains radioactive material. Small items will be delivered to Radiological Safety Section, Bldg. 550, and they will accomplish final delivery. Notify Radiological Safety Section immediately upon receipt of larger items for clearance prior to delivery (see Section VI, paragraph 2).

5. ISOTOPE INVENTORY AND SHIPMENT

The Radiological Safety Section will conduct periodic isotope inventories for control purposes, and reserves the right to request periodic reports concerning the use made of the isotopes or equipment. Each Radiation Area Supervisor should keep accurate records of receipt, expenditure, and relocation of radioactive materials for which he is responsible. Transfer of materials between radiological areas is sometimes permissible, but only with prior approval by the Radiological Safety Section. Transfer of any amount of radioactive material to unauthorized areas is prohibited. Off-post shipment of radioactive material must be cleared through the Radiological Safety Section to assure conformance with Atomic Energy Commission, Interstate Commerce Commission, Postal and other shipping regulations as well as with Radiological Safety inventory requirements.

6. INACTIVATION OR AMENDMENT OF A RADIOLOGICAL PROGRAM

a. Inactivation

(1) Whenever a Radiological Program is to be discontinued or a radiation area is to be returned to nonradiological use, the Radiological Safety Section will be notified in writing by the Radiation Area Supervisor. Before any of the above actions can take place, the Radiological Safety Section will check the program to insure that:

(a) The area is free of all radioactive materials and contaminants.

(b) All radiation caution signs and labels are removed.

(c) All radioactive material that is still in the possession of the user is stored in the radiological holding area or that the disposal of such material has been properly carried out.

(d) Film badge services are discontinued.

(e) Other pertinent radiological safety matters have been completed.

(2) Once these matters have been completed, the Radiological Safety Section will notify the Radiation Area Supervisor in writing that the area has been cleared and may be returned to nonradiological use. A radiation area will not be considered as cleared for nonradiological use until the Radiological Safety notification is received by the Radiation Area Supervisor.

b. Amendments

Any change in procedure or personnel involved in a Radiological Program will require that a written amendment to the program be submitted to the Fort Detrick Isotope Committee for approval prior to any such change.

III. GENERAL RULES AND PRECAUTIONS FOR USE OF RADIATION

1. THE NATURE OF RADIATION HAZARDS

a. Work with radioactive materials or radiation-producing devices can be accomplished without undue hazard to personnel provided that the dangers are recognized and the necessary precautions understood and employed. Basic procedures for the safe use of isotopes and radioactive sources involve protection against external and internal radiation. Suitable protection can usually be provided by appropriate combinations of several factors: (a) planning the activity to use minimal quantities of radioactive materials; (b) maintaining proper distance between source of radiation and worker; (c) limiting the time of exposure to radiation; (d) utilizing adequate shielding between source and worker; (e) handling dusty material in closed systems; and (f) limiting the spread of contamination caused by accidents.

b. Certain basic facts are generally accepted about the biological effects of ionizing radiation. It is beyond the scope of this manual to give an extensive discussion of these effects, but a few of the fundamental principles are presented to clarify the regulations and precautions that follow.

c. The biological effects of radiation are primarily due to its ionizing effect, which may cause injury or death to living cells. Ionizing radiation penetrates the individual cells and the energy transferred is high enough to cause changes in the cell physiology, to the extent that serious injury or even death may result. Obviously, if enough of the cells are injured or killed, serious impairment of single organs or even of total body functions may occur.

d. All types of cells and tissues are affected by ionizing radiation. However, different tissues vary in radiosensitivity and in ability to recover from radiation damage. Those tissues most affected are the blood-forming tissues, epithelial tissues of the intestine, and the skin and the lens of the eye. In man the early effects of exposure to ionizing radiation are the reduction of the number of leukocytes in the blood, erythema, epilation, inhibition of gamete formation, and capillary damage. The degree of damage to any particular tissue, however, depends upon the type of radiation, the method by which the tissue is exposed, and the amount of radiation absorbed.

e. In addition to these early effects, there are marked cumulative effects and late changes. These long-term or cumulative effects have no detectable threshold area and, as the term implies, are cumulative over the entire lifespan of the individual concerned. The most important of these cumulative effects is the genetic damage caused to the reproductive organs.

f. In the field of radiation safety, two basic types of radiation hazards are recognized: external and internal. The source of an external hazard may be an X-ray machine, an accelerator, any radioisotope, or other material or equipment that emits gamma rays or neutrons. Alpha, proton, deuteron, and beta particles, emitted from accelerating equipment or other materials, are external hazards to a varying degree that is dependent upon their energy range and source.

g. Even though it may seldom occur that the whole body is subjected uniformly to external radiation, it is, nevertheless, necessary in the interest of safety to assume that this always takes place and to regard such an exposure as "total body dose" rather than a "limited body dose." This, however, obviously does not apply when the radiation dose received is given to the wrist, finger or some other appendage of the body (See Section V, paragraph 1) while the main portion of the body is shielded.

h. Internal radiation exposures occur when radioisotopes enter the body by means of inhalation, ingestion, through an open wound or through the pores of the skin. From the internal dose standpoint, all radioactive materials are considered a hazard. Materials such as Ra^{226}, Pu^{239} and Sr^{90} are absorbed primarily into the bone, causing injury to the blood-forming organs. Other radioisotopes may concentrate in different tissues or organs; for example, I^{131} is absorbed primarily by the thyroid. As in the case of external dosage, symptoms of radioactive injury may occur in a few days or weeks in severe cases or may not appear for years if small amounts of radioisotopes have been absorbed.

i. Therefore, it is imperative that persons engaged in laboratory operations involving the use of radioisotopes be aware of the fact that an internal as well as an external radiation hazard may exist.

2. MAXIMUM PERMISSIBLE DOSE

a. No individual employed at the U.S. Army Biological Laboratories shall be exposed to ionizing radiation in excess of the limits given in this publication or in the "Code of Federal Regulations."*

b. The maximum permissible dose that may be received by a radiation worker for a calender quarter* is given in Table I.

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* "Code of Federal Regulations," Title 10, Part 20, paragraph 20.101 November 17, 1960.

TABLE I. MAXIMUM PERMISSIBLE DOSE PER CALENDAR QUARTER

	Parts of the Body	Exposure, Rems*
1.	Whole body; head and trunk; active blood-forming organs, lens of eyes, or gonads	1-1/4
2.	Hands and forearms, feet and ankles	18-3/4
3.	Skin of whole body	7-1/2

c. Radiation exposures resulting from necessary medical and dental procedures will not be included in the determination of the radiation exposure status of any individual except in instances where large amounts of radiation therapy have been received (Section V, paragraph 4).

d. The maximum permissible dose of any individual less than 18 years of age, pregnant, or not working in a radiological occupation or in a radiological area will not exceed ten per cent of the values in Table I.

e. No individual in any unrestricted radiation area will be exposed to ionizing radiation from radioactive material or other sources of radiation in his possession at any level that, if he were continuously present in the area, could result in his receiving a dose in excess of (a) two millirems in any one hour, or (b) 100 millirems in any seven consecutive days.

f. A dose rate of 2.0 millirems per hour will be the maximum allowable in areas where radiation workers are present for forty hours per week. In any period in which the number of hours of exposure is less or greater than forty, the limit specified above shall be increased or decreased proportionately.

g. In instances where the exposure values of Table I are exceeded, the Radiological Safety Section will investigate the overexposure immediately to ascertain the cause. The individual exposed will be restricted from all work involving ionizing radiation until his average exposure is below the tolerances given in Table I, and will be treated under the provisions given in Section IV, paragraph 3, of this publication.

* Roentgen Equivalent for Man (See Glossary).

h. To insure that maximum permissible exposure levels are not exceeded, the Radiological Safety Section will perform routine radiation area surveys of all radiological facilities on a periodic basis. Under certain circumstances, the Radiological Safety Section may require that a Radiological Safety monitor be present during all radiological operations (Section II, paragraph 2).

3. MAXIMUM PERMISSIBLE CONCENTRATIONS OF RADIOISOTOPES IN THE ENVIRONMENT

a. Radioisotopes will not knowingly be released to the environment at Fort Detrick.

b. Normally, radioactive liquids will be disposed of in containers for liquid radioactive waste (Section VI, paragraph 4).

4. MAXIMUM PERMISSIBLE LEVELS OF RADIOACTIVE CONTAMINATION

a. The maximum permissible levels of radioactive contamination on hoods, bacteriological cabinets, laboratory benches, other working surfaces, floors and other areas will not exceed the values in Table II.

TABLE II. MAXIMUM PERMISSIBLE CONTAMINATION LEVELS

Type of Radiation	Transferable Activity	Total Activity
Alpha	10 dis/min/100 cm^2 wiped area	300 dis/min/100 cm^2 area
Beta-Gamma	500 dis/min/100 cm^2 wiped area	0.1 mrem/hr

b. The permissible levels on glassware, tongs, lead bricks, and other laboratory equipment will be the same as those for working surfaces; however, it is expected that, in certain instances in which such equipment is to be used over again in radiological operations, contaminated equipment will be present and is permissible as long as it is stored separately from uncontaminated equipment, preferably in a properly marked fume hood or bacteriological cabinet (See Section III, paragraph 8). The glassware will be labled as being radiologically contaminated and not to be removed from the laboratory. Table II shall apply to inner working surfaces of fume hoods or cabinets as well as to laboratory equipment.

c. To insure that these levels are maintained, the Radiological Safety Section will perform routine radiation area surveys of all radiological facilities periodically.

5. EQUIPMENT AND INSTRUMENTATION

a. Hoods

A fume hood will be used in all radiological operations in which there is any chance of air pollution by radioisotopes. The inside surfaces will be constructed of stainless steel or covered with a strippable paint for easy decontamination. The air flow into the working opening or window will have a linear velocity of at least 100 feet per minute and shall not exceed 200 feet per minute. The hood should be of the Oak Ridge National Laboratory (ORNL) type with air foils and an approved filter. The filter will be installed as near the entrance of the hood exhaust as possible to prevent contamination of the exhaust system.

b. Bacteriological Safety Cabinets Class I and III

For operations where the hazard due to air-borne radioactive contamination is great, a bacteriological cabinet will be used. The Radiological Safety Section will determine whether a bacteriological cabinet Class I or III is necessary prior to beginning operations. The cabinets shall have a recently changed approved exhaust filter and an exhaust system capable of maintaining a continuous negative pressure (not less than 0.5 inch water) in the cabinet. The inside surfaces must be easily decontaminated.

c. Filters

Each fume hood and bacteriological safety cabinet, Class I or III, will be equipped with an exhaust filter which can effectively remove particles of 0.3 microns or larger. The recommended filter is a fiber web Mine Safety Appliances (MSA) ultra-air space filter or equivalent.

The filter housing will be labeled with the radiation symbol and the notice "Radiation Hazard - Contact Radiological Safety Section (Ext. 7167) before changing this filter."

d. Remote Handling Equipment

Remote handling equipment such as tongs, forceps, clamps, mechanical arms, etc., should be available for radiological operations. The amount or type will, of course, depend on the amount of activity and other factors in any radiological operations. Radioisotopes in activity quantities larger than one or two microcuries should not be handled with the hands.

e. Shielding

(1) The Radiological Safety Section will check during periodic surveys to insure that adequate shielding is used in all radiological operations. The total amount of shielding material that will be necessary will depend on the amount of activity and the type of radiation involved. In some instances it may be necessary to construct a "hot cell" or large shielding barrier to meet shielding requirements. The Radiological Safety Office will be available for consultation on all shielding problems encountered.

(2) Some efficient shielding materials for various types of radiation are listed below:

Radiation Type	Shielding Materials
Gamma or X-rays	Lead or concrete
Beta Particles	Lucite or other plastics of low atomic number
Neutron Particles	Water, paraffin or Barytes concrete

(3) Alpha particles do not pose a serious shielding problem inasmuch as they are effectively absorbed in a short distance by the air.

f. Working Surfaces, Floors, and Walls

(1) All working surfaces will be constructed of materials that are nonporous and resistant to attack by solutions containing radioactivity. These shall be capable of decontamination with acid or base solutions and have flush seams or be seamless to simplify decontamination. In general, stainless steel, tempered glass or plastics of a strippable nature are usually satisfactory. Bare concrete will not be used as flooring. The floors will be constructed with a nonporous covering such as stainless steel, vinyl plastic tile, asphalt tile or heavy-duty linoleum with a thick wax coating. Laboratories or other areas with wooden floors or working surfaces will not be used for radiological operations.

(2) The walls and ceilings of radiological laboratories should, whenever possible, be constructed of nonporous materials or covered with a heavy coating of strippable paint or heavy-duty waterproof paper for easy decontamination.

g. Survey and Monitoring Instruments

All radiological operations or laboratories will be equipped with some type of radiation laboratory monitor or survey instrument to check radiation levels and check for possible radiological contamination of personnel or equipment. Type or number of instruments necessary will again depend on the radioisotope being used, its physical form, the amount of activity involved, and other pertinent factors. The Radiological Safety Section will be available for consultation on detection and instrument problems encountered.

6. PROTECTIVE CLOTHING AND DEVICES

a. In all instances where personnel enter a radiation area where radiological contamination exists, they will be required to wear laboratory clothing to prevent contamination.

b. If clothing becomes radiologically contaminated, it will be placed in a plastic bag, biologically decontaminated by treatment with ethylene oxide, and the Radiological Safety Section will be notified for its proper removal and treatment.

c. Personnel working or present in areas or laboratories where airborne radioactive contamination exists in activity levels in excess of the values listed in Appendix B, 10 CFR 20, will be required to wear protective respirator equipment. The type of equipment needed for different activity levels is listed below:

Type of Respiratory Equipment	Activity Levels
Respirators or half-face masks	Greater than the values listed in Appendix B, 10 CFR 20
Full-face masks Chemox Masks	Ten times the values listed in Appendix B, 10 CFR 20
Outside-air-supplied masks or equipment	Fifty times the values listed in Appendix B, 10 CFR 20

d. All respirator masks that have a filter cartridge will be supplied with MSA type H ultra-cartridges or the equivalent.

e. The Radiological Safety Office will ascertain the amount of air-borne radioactivity present in any area and recommend the amount and type of protective clothing or other equipment needed for all radiological operations.

f. The following equipment will be procured by the division concerned for this type of operation:

(1) Protective respiratory masks.

(2) Rubber surgeon's gloves or seamless plastic disposable gloves.

(3) Masking tape.

7. RADIATION AREAS

a. A radiation area shall be considered to be any room, building, enclosure, or open area accessible to personnel where radioisotopes and other sources of ionizing radiation are used and/or stored for a period greater than eight hours.

b. The following is a list* of types of radiation areas and the standards to be used in determining each type:

(1) "Radiation Area" shall mean any area accessible to personnel in which the radiation dose rate is such that a major portion of the body could receive in excess of five millirems per hour.

(2) "High Radiation Area" shall mean any area accessible to personnel in which the radiation dose rate is such that a major portion of the body could receive in excess of 100 millirems per hour.

(3) "Air-Borne Radiation Area" shall mean any area in which the air-borne radioactivity exceeds the limits prescribed in Appendix B, 10 CFR 20, or where concentrations, averaged over the number of hours in any week during which individuals are present in the area, exceed 25 per cent of the amounts listed in Appendix B, 10 CFR 20.

(4) "Radioactive Material Area" shall mean any area in which radioisotopes are present in activity levels ten times the levels that are specified for each radioisotope in Appendix C, 10 CFR 20, or any ten radioisotopes listed in Appendix C, 10 CFR 20 in the activity levels specified, or more than one hundred times the activity levels specified for natural uranium or natural thorium, but are below the requirements for any other type of area.

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* "Code of Federal Regulations," Title 10, part 20. November 17, 1960.

c. All radiation areas will be conspicuously marked or posted with radiation caution signs of the design described in Section III, paragraph 8, of this manual.

8. RADIATION CAUTION SIGNS AND LABELS

a. All radiation caution signs and labels shall be the conventional radiation caution colors (magenta or purple on a bright yellow background) and shall display the radiation caution symbol, the design of which is shown in Figure 1.*

b. All radiation caution signs for radiation areas shall have the radiation caution symbol and the words:

CAUTION

RADIATION AREA

DOSE RATE AT THIS POINT

IS

_____

c. All radiation caution signs for high radiation areas shall have the radiation caution symbol and the words:

CAUTION

HIGH RADIATION AREA

DOSE RATE AT THIS POINT

IS

_____

d. All radiation caution signs for air-borne radiation areas shall have the radiation caution symbol and the words:

CAUTION

AIR-BORNE RADIOACTIVITY AREA

DO NOT REMAIN IN THIS AREA

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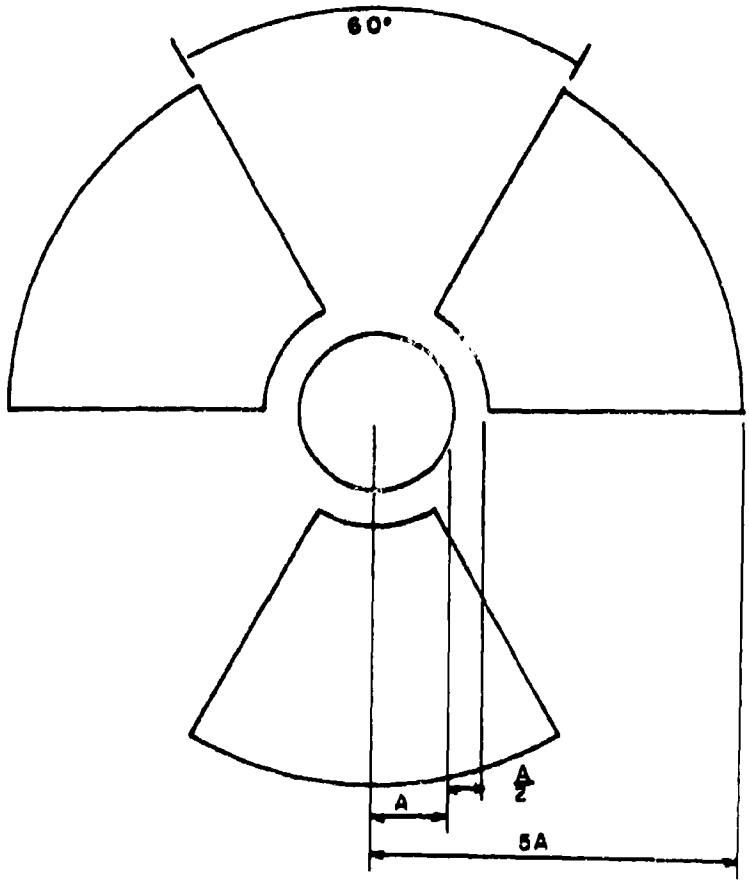
* Figure 1: Radiation Symbol Design and CFR Title 10, part 20 paragraph 20.203.



SPECIFICATIONS:

1. DIMENSIONS; The standard radiation symbol has the above ratio of dimension, 'A' being any desirable size.
2. COLOR: The standard radiation warning sign colors, magenta symbol and letters on yellow background, are specified in AR 385-30
3. ADDITIONAL INFORMATION: The unused portion of the sign may be used to display furthur warnings, such as; 'KEEP OUT, DANGER-RADIOACTIVE CONTAMINATION, ETC., whenever such warnings are appropriate

Figure 1. Standard Radiation Symbol.

e. In all radioactive materials areas where the radiation levels are below the requirements listed for a radiation area, a radiation caution sign will be used that shall have the radiation caution symbol and the words:

CAUTION

RADIOACTIVE MATERIALS

f. In addition to the preceding requirements, radiation caution signs may display further warnings such as "Keep Out"; Danger, Radioactive Contamination"; etc., whenever such warnings are appropriate. In all cases, the Radiological Safety Section will be responsible for the posting of all radiation areas.

g. Radiation caution signs or labels will be attached to all fume hoods, bacteriological cabinets, containers and other equipment that contain or are contaminated with any amount of radioactive materials. These signs will have the following information printed on them: (a) the radiation caution symbol; (b) the words "Caution, Radioactive Materials;" (c) the radioisotope involved, if known; (d) the type of radiation (alpha, beta, or gama) present; (e) level of activity; (f) date of measurement; (g) the dose rate if any; and (h) the name of the organization that placed the tag on the equipment.

h. In addition to signs, barricades, ropes, painted lines on the floor, etc. may be used at the discretion of the Radiation Area Supervisor or the Radiological Safety Section whenever their use is thought advisable.

i. All sealed source capsules with activity levels greater than ten times the valves given in Appendix C, 10 CFR 20 will be plainly marked with a radiation caution tag one by two inches bearing (a) the radiation caution symbol; (b) the words "Caution, Radioactive Materials;" (c) the radioisotope; (d) the amount of activity present in the container; (e) date of measurement; and (f) "Do Not Handle, Notify Military Authorities, Fort Detrick, Frederick, Maryland, If Found."

j. In addition, all containers used to store radioisotopes of activity levels in excess of fifty millicuries will be painted a bright yellow and plainly marked in magenta or purple with a radiation caution symbol and the words "Caution, Radioactive Materials." The following information will also be printed or painted on the container: (a) the radioisotope; (b) the radiation dose rate at the surface of the containers and at one meter from the surface of the container; and (c) the amount of activity present in the container.

k. It is realized that it is impracticable or impossible to tag sources used in certain special devices. In cases of this nature, either the container or the device will be tagged instead of the source.

l. Tags, signs, and labels may be procured upon request from the Radiological Safety Section for use in radiological operations.

m. For tagging and labeling instructions for shipment and transfer of radioisotopes, see Section VI, paragraph 2.

9. RADIATION ALARM AND CONTROL SYSTEMS

a. All high radiation areas and air-borne radioactivity areas will be equipped to prevent unauthorized entry.

b. In addition, each high radiation area will be equipped with a control device that shall either cause the radiation dose level to be reduced below 100 millirads per hour upon entry into the area or will energize a conspicuous visible or audible alarm signal in such a manner that the person entering and the operational personnel are made aware of the unauthorized entry. This requirement is unnecessary if the high radiation area is set up on a temporary basis for a period of less than 30 days.

10. DECONTAMINATION PROCEDURES FOR EQUIPMENT

a. Decontamination of laboratory and other equipment as well as laboratory areas is a problem of fundamental importance to all personnel engaged in the use of radioisotopes. Constant vigilance to prevent contamination or to limit its spread must be maintained at all times.

b. In cases where biological materials are used, the biological decontamination or sterilization must be considered and performed before radiological decontamination.

(1) Equipment and material should be placed in a nonporous container for autoclaving or ethylene oxide treatment. After proper bacteriological sterilization, initiate the radiological decontamination.

c. The following are suggested procedures that should be used to decontaminate small amounts of contaminated laboratory equipment or glassware. However, in the case of any radiation spill or loss of control, the Radiological Safety Section (Ext. 7167) shall be contacted immediately. All areas or laboratories involved in a radiation spill will be monitored and cleared by the Radiological Safety Section before being returned to normal usage (see Section IV).

(1) Thorough washing with soap or a strong detergent, using a minimum amount of water and wiping dry with absorbent gauze, is usually a good starting point for decontamination of all types of equipment except electrical.

(2) Should the preceding fail to reduce the activity to the desired limits after several attempts, the following decontaminating agents may be tried:

(a) Wood and concrete - sodium versenate, oxalic or citric acid solutions.

(b) Stainless steel - wash with or immerse in a saturated sodium dichromate solution containing a few milliliters of concentrated sulfuric acid or in an agitated solution of three per cent hydroflouric acid and 20 per cent nitric acid for one hour. Never use hydrochloric acid on stainless steel. Electrolysis is often successful in decontaminating alpha-contaminated stainless steel. A mixture of two or three per cent oxalic acid or a mixture of two or three per cent sulfuric acid should be used in this procedure.

(c) Black iron, chrome steel alloys, concrete and other porous materials can sometimes be decontaminated by controlled sandblasting or grinding. This operation will require special ventilation facilities to prevent air-borne contamination (See Section III, paragraph 5 and 6).

(d) Electrical equipment should be disconnected, wiped down with absorbent gauze dampened with decontamination solution, and then sprayed with trichlorethylene or other solvents and wiped dry with absorbent gauze.

(e) Glassware should be washed with chromic acid or nitric acid mixed with detergent solution and rinsed thoroughly.

(3) The amount of decontaminating solution should be kept to the absolute minimum for all operations to prevent large amounts of liquid waste from accumulating.

11. PERSONNEL DECONTAMINATION

a. The chief objective in personnel decontamination is to remove the radioactivity from the body as quickly and safely as possible. First, remove all contaminated clothing and monitor body to specifically locate all contaminated skin areas. If the contamination is confined to a small area, (i.e., hands and forearms) decontamination may be performed in the local laboratory area. However, if the body is generally contaminated, the person involved will be dressed in expendable clothing and taken to the showers.

b. Wash contaminated areas thoroughly with soap and water. Dry skin completely (especially in the case of alpha contamination) before monitoring. If contamination remains, repeat process. If contamination is still present after repeating this process the Post Surgeon should be consulted.

c. Avoid prolonged use of any one method of decontamination because skin irritation might result and thus impede the success of other procedures as well as lead to possible absorption of contaminated material through breaks in the skin.

12. LEAK-TESTING SEALED SOURCES

a. Sealed sources containing radioisotopes that emit beta and/or gamma radiation will be leak-tested at least every six months by the Radiological Safety Section or designated representative. Sealed sources containing alpha emitters will be leak-tested every three months. The leak tests will be made on all radioactive sealed sources with activity levels of greater than ten times the activity levels for the radioisotopes listed in Appendix C, 10 CFR 20.

b. The procedure used for leak-testing radioactive sealed sources is:

(1) A piece of filter paper 4.25 centimeters in diameter is dampened with water and rubbed over the surface of the source. If this is not possible, the container or the area where the source has been stored is treated in the same manner.

(2) The filter paper is then counted for the presence of radioactive contamination, using a laboratory scaler and a beta-gamma or an alpha detector.

(3) If radioactive contamination is found, the source will be immediately impounded by Radiological Safety Section and restricted from use.

(4) The source will be decontaminated with remote handling equipment, if it is suspected that the radioactive contaminant is not from the radioisotope inside the source. The source will be rechecked within a week to ten days before being returned to the user.

c. In the case of sealed sources containing radium, an additional test will be made for possible radon leakage. This test will be performed by placing the source in a container and plugging the end of the tube or bottle with cotton. After allowing the source to remain in this condition for 24 hours, the cotton plug will be removed from the bottle and counted

for radon daughter products using an alpha detector and laboratory scaler. If radon daughters are found to be present, the source shall be considered a "leaker" and impounded.

13. RADIOLOGICAL SANITARY AND OTHER PRECAUTIONS

a. The following precautions should be followed in all radiological laboratories and test areas to prevent possible personnel injury involving ionizing radiation in addition to Biological Regulations (January 1963) for infectious disease laboratories:

(1) Eating, drinking and smoking shall be strictly prohibited in areas or laboratories where radioisotopes in unsealed form are used.

(2) In handling radioisotopes in unsealed form, rubber surgeon's gloves or approved equivalent shall be worn.

(3) Pipetting radioisotopes by mouth or any other operations in which possible ingestion of the material may occur is strictly prohibited.

(4) All hoods, cabinets, and working surfaces where radioisotopes other than sealed sources are to be used should be covered with paper, absorbent gauze, polyethylene or some other protective covering to help prevent contamination to these surfaces.

(5) Laboratory clothing (See Section III, paragraph 6) shall be worn in all radioisotope operations not involving sealed sources.

(6) When personnel move from an area where radioisotopes in unsealed form are present to a nonradiation area, or have completed operations using radioisotopes, they shall first monitor themselves to insure that they are not contaminated.

(7) Glassware and other equipment used in radioisotope operations will be carefully monitored and decontaminated if necessary before being returned to normal supply stocks. Excessive amounts of contaminated glassware and equipment should never be allowed to accumulate.

(8) Care will be taken to mark and segregate all contaminated equipment and glassware (See Section III, paragraph 8).

(9) Facilities will always be available for the safe storage of radioisotope stock solutions and contaminated equipment (See Section III, paragraph 5).

(10) Before embarking on a new operation involving radioisotopes, a "dry run" shall be performed to insure that all necessary precautions are being taken.

(11) Survey meters in good working order shall always be available for work involving ionizing radiation to monitor both working areas and personnel.

(12) Caution shall always be exercised when entering a high radiation area. A high-range ionization-type survey meter shall be used to monitor the area as personnel are entering to ensure that they will not be overexposed.

(13) Shielding will be checked by the Radiological Safety Section prior to the beginning of an operation involving ionizing radiation.

(14) The storage of food and cigarettes, etc., in areas or equipment that are used for radioisotope storage is strictly prohibited.

(15) Wash hands thoroughly at the completion of any operation involving radioactive materials.

(16) High standards of hygiene and good housekeeping shall be maintained in radiation areas at all times.

b. Any exception to the preceding precautions taken by any group using radioisotopes or equipment producing ionizing radiation must first be approved by the Fort Detrick Isotope Committee in writing. In addition, the administration of any radioisotope of any activity level to any human being for experimental purposes is strictly prohibited unless first approved in writing by the Surgeon General and AEC.

IV. ACCIDENTS INVOLVING RADIATION

1. RADIATION SPILLS OR LOSS OF CONTROL

a. The following procedures shall be observed in dealing with a radiation spill or loss of control at any facility or area at Fort Detrick.

(1) Evacuate all personnel to an area of known safety and close all entrances into the hazard area to prevent the entry of other personnel.

(2) If air-borne radioactive contamination is known or suspected, close all portals.

(3) Inform the Radiological Safety Section (Ext. 7167) of the accident and its location.

(4) Keep all personnel known or suspected of being radioactively contaminated confined to one area to prevent further spread of contamination.

b. The Radiological Safety Section will immediately dispatch personnel and necessary equipment to the scene of the accident and shall perform the following upon arrival:

(1) Ascertain that all personnel have been evacuated from the hazard area and insure that entry into the hazard area has been restricted.

(2) Monitor all known or suspected radioactively contaminated personnel and determine the extent of contamination.

(3) Start personnel radiological decontamination operations immediately (Section IV, paragraph 4).

(4) Reevaluate the hazard area to insure that its limits have been properly established.

(5) Plan and supervise the decontamination of the area or the reestablishment of safe radiation dose limits, utilizing personnel furnished by the division in which the accident occurred. The actual decontamination or other operations will be performed by these personnel.

(6) Monitor all areas where decontamination or other operations have been completed to insure that a radiological hazard no longer exists and clear all areas to be returned to normal usage.

(7) The Radiological Safety Section will investigate the cause of the accident and advise the Radiation Area Supervisor on precautions to be taken to prevent a recurrence of such an accident.

(8) The Radiological Safety Section shall report the incident as required by Section IV, paragraph 5 of this publication.

2. FIRES OR EXPLOSIONS INVOLVING RADIOISOTOPES

a. When a fire or explosion occurs involving radioisotopes or an area or laboratory at Fort Detrick in which radioisotopes are used, handled or stored, the proper damage control office will be called and the Radiological Safety Section will be notified immediately (Ext. 7167).

b. All damage control equipment and personnel will be monitored by the Radiological Safety Section personnel before being permitted to leave the scene of the incident if radioactive contamination is present.

c. All damage control personnel will be equipped with the necessary dosimetric (See Section V, paragraph 1) and protective (See Section III, paragraph 6) equipment.

d. If it is known or suspected that damage control or other personnel in the area have been radiologically contaminated or overexposed to ionizing radiation, they will be treated under the provisions of Section III, paragraph 11, Section IV, paragraph 3, and Section IV, paragraph 4 of this publication.

e. The following responsibilities will be assumed in regard to fires or explosions involving radioisotopes:

(1) Fire Department will:

(a) Be thoroughly familiar with the location of all "High Radiation Areas," "Air-borne Radioactivity Areas," and "Radiation Areas," and be able to recognize all radiation caution signs and be able to understand their meaning.

(b) Notify the Radiological Safety Section of the location of any fire involving radioisotopes.

(c) Wear and enforce the use of dosimetric and protective equipment by damage control personnel.

(2) Military Police and Security Guard will:

(a) Notify the Radiological Safety Section personnel of any radiation accident during nonduty hours.

(b) Be thoroughly familiar with radiation caution signs and understand their meaning.

(c) Support Radiological Safety Section in minimizing the exposure of personnel to radiation hazards.

(3) Post Dispensary will:

(a) Be thoroughly familiar with radiation caution signs and understand their meaning.

(b) Wear necessary dosimetric and protective equipment as instructed by Radiological Safety Section.

(c) Observe special precautions and procedures prescribed by the Post Surgeon and the Surgeon General in handling radiologically contaminated casualties.

(4) Radiological Safety Section will:

(a) Keep the Fire Marshal informed on the location of all "High Radiation Areas," "Air-borne Radioactivity Areas," and "Radiation Areas."

(b) Furnish dosimetric and protective equipment to all damage control personnel and police as required.

(c) Keep Military Police Radio Room informed on the telephone number and personnel to be notified should a fire or explosion occur during nonduty hours.

(d) Bring necessary radiation protection equipment to the scene of the incident.

(e) Recommend patrol lines to restrict the area from personnel entry following the incident, but only on the basis of the radiation hazard involved.

(f) Report the incident as required by Section IV, paragraph 5, of this publication.

3. OVEREXPOSURE OF PERSONNEL TO IONIZING RADIATION

a. External Exposure

(1) In the event of a known or suspected external exposure of any individual at Fort Detrick to ionizing radiation in excess of the maximum permissible limits given in Section III, paragraph 2, Table I, of this publication, or if a dosimetric device worn by any individual indicates that he has received an overexposure, the Radiological Safety Section will be

contacted immediately (Ext. 7167). All such reports of overexposure will be immediately investigated by the Radiological Safety Section, and a determination of the validity of the overexposure incident made.

(2) The individual involved will be taken to the Post Dispensary for a medical examination and a blood count. The individual will return to the Post Dispensary for three consecutive days for a blood count and every week thereafter for a period of three consecutive weeks. The individual concerned will not be cleared by the Post Surgeon to return to work involving ionizing radiation if his average total body exposure for a given quarter period is above the maximum permissible dose shown in Section III, paragraph 2. For example: if an individual receives total body dose of 1.1 Rems for a period of one day, he will not be cleared to return during the quarter to work involving ionizing radiation if his average total body dosage in the quarter (including the 1.1-Rem dose he received in one day) is over 1½ Rems. (Note: This would require a report to AEC through channels.)

b. Internal Exposure

(1) For the purposes of this publication any ingestion, inhalation, or absorption of radioisotopes will be considered an emergency poisoning case and will be treated as such. In the event that an individual has ingested, inhaled, or absorbed any amount of radioisotopes, the Post Dispensary (Ext. 4159) and the Radiological Safety Section (Ext. 7167) will be contacted immediately. The Post Dispensary and the Radiological Safety Section will investigate the incident at once. Radiological emergency first aid will be administered as necessary (See Section IV, paragraph 4). The Medical Officer in charge at the Post Dispensary will be informed of any radiological first aid treatment that has been administered.

(2) Upon evaluation of the incident, the Radiological Safety Section will report all information on the exposure to the doctor in charge.

(3) Medical examination will be made in any case in which an internal exposure is either known or suspected, and blood counts taken for three consecutive days following the incident and for three consecutive weeks at weekly intervals. During this time, the individual will be utilized elsewhere, according to his physical ability, where his work will not involve exposure to ionizing radiation.

(4) Where instances of internal exposure are indicated, arrangements for bio-assay will be made (See Section V, paragraph 3) to determine the body burden of radioisotope received.

c. Clinical Management of Overexposure

In all incidents of external and/or internal overexposure to ionizing radiation, the Post Surgeon will be responsible for the clinical management of the case.

d. Such exposures will be reported under the provisions of Section IV, paragraph 5.

4. RADIOLOGICAL FIRST AID

a. In the event of an internal exposure due to the entrance of radioisotopes into the body, the following radiological first aid procedures should be used prior to the arrival of medical personnel for the type of exposure listed:

(1) Ingestion

Individuals accidentally swallowing material containing radioactive isotopes will be treated for poisoning to remove the maximum amount of material as quickly as possible. It is of prime importance to obtain immediate medical attention for the victim. Until direct medical supervision has been obtained it is recommended that vomiting be induced. Gentle stroking or touching the throat with the finger or tongue depressor will aid vomiting when the stomach is full of fluid. Remove individual to the biologically clean side of building as soon as possible. If an emetic is required, give sodium chloride (table salt) 15 grams (one tablespoon) in a glass of warm water. One to three teaspoonsful of powdered mustard in a glass of warm water can also be used. An emetic should not be given after poisoning by corrosive acids or caustic alkalies nor should it be given if the victim is vomiting.

(2) Inhalation

The following is suggested if air-borne radioactive isotopes are inhaled: Material from the nasal passages should be removed with Q-Tips. Irrigating nasal passages by sniffling dilute salt solution (½ teaspoon of salt in a glass of lukewarm water) up the nose will remove particles. Gargling with dilute warm salt solution is also recommended. The use of nasal irrigation should be avoided unless under medical supervision. Removal of the remainder of foreign material in the respiratory tract should be performed under the direct supervision of a qualified physician.

(3) Cuts and Punctures

Individuals cut by broken glassware or injured with hypodermic needles, etc., that are contaminated with radioisotopes should wash the wound immediately under a strong jet of water. The injured person will immediately contact the Post Dispensary and Radiological Safety Section and be considered as having an internal exposure (see Section IV paragraph 4).

(4) Skin Contamination

If the method recommended in Section III, paragraph 11, of this publication proves ineffective in skin decontamination, the case will be referred to the Post Surgeon.

5. RADIOLOGICAL ACCIDENT REPORTS

a. When radioisotopes or sources of ionizing radiation are involved in a fire, explosion, theft, loss of control, spill, overexposure of personnel, or any other type of accident at Fort Detrick, the following agencies will be contacted as required by regulation in the manner prescribed below. In all instances where reports must be submitted or notification made to the Atomic Energy Commission, the Surgeon General or any other agency, these reports and notifications will be prepared by Radiological Safety Section.

b. Radiological Safety Accident Reports

(1) In all instances of fire, explosion, theft, spills, loss of control, personnel overexposure, or any other accident involving radioisotopes or ionizing radiation, the Radiological Safety Section shall be notified immediately by telephone (Ext. 7167).

(2) In all instances in which personnel are overexposed to ionizing radiation, a written report in triplicate will be submitted to the Radiological Safety Section (in addition to the telephone notification) within 24 hours after the overexposure has occurred. This report will be prepared by the Radiation Area Supervisor named on the Radiological Test Program involved and will contain the following:

(a) The name and location of the organization where the overexposure occurred.

(b) The Radiological Program Number assigned to the project.

(c) The name of each individual who received an overexposure.

(d) The source of the ionizing radiation and if radioisotopes are involved, the element, chemical and physical form, and the activity level.

(e) A brief resume of how the overexposure occurred.

(f) Corrective steps that will be taken to prevent a recurrence of the incident.

(g) A signed statement (in duplicate) from each individual who received an overexposure, relating his actions prior to and after the exposure. This statement will be filed with the individual's exposure record, which is kept in the Radiological Safety Section (See Section V, paragraph 1).

c. Atomic Energy Commission Accident Reports*

When radioisotopes that are licensed by the Atomic Energy Commission are involved in a fire, explosion, theft, spill, personnel overexposure or loss of control, the incident will be reported to the Radiological Safety Section, who will notify the Atomic Energy Commission in these instances and using the following procedures:

(1) In case of the loss or theft of licensed radioisotopes in quantities and under circumstances such that a substantial hazard exists to persons in unrestricted areas, the Atomic Energy Commission New York Operations Office will be contacted immediately by telephone and telegraph.*

(2) Immediate notification by telephone and telegraph will be made to the Manager, AEC New York Operations Office, of any incident involving licensed radioisotopes that caused or threatens to cause the following:**

(a) Exposure of any individual to a radiation dose of 25 Rems or more, including radioisotopes that have been taken into the body.

(b) The release of radioisotopes in concentrations that, if averaged over a period of 24 hours, would exceed 5000 times the values listed in Appendix B, Table II, 10 CFR 20.

(c) A loss of one working week or more of the operation of any facilities affected.

(d) Damage to property in excess of $100,000.

(3) The Manager of the AEC New York Operations Office will be notified within 24 hours by telephone and telegraph of any incident involving licensed radioisotopes that has caused or threatens to cause the following:**

(a) Exposure of any individual to a radiation dose of five Rems or more including radioisotopes taken into the body.

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* Code of Federal Regulations Title 10, Part 20.
** Code of Federal Regulations Title 10, Part 20, para. 20.402 and 20.403.

(b) The release of radioisotopes in concentrations that, if averaged over a period of 24 hours, would exceed 500 times the values given in Appendix B, Table II, 10 CFR 20.

(c) A loss of one day or more of operation of any facilities affected.

(d) Damage to property in excess of $1,000.

(4) A report shall be made to the Director, Division of Licensing and Regulation, Atomic Energy Commission within thirty days of each incident involving licensed radioisotopes that has caused the following:

(a) Exposure of any individual to a radiation dose of 900 millirems or more, including radioisotopes that have been taken into the body.

(b) The release of radioisotopes that, if averaged over a period of 24 hours, would exceed the values given in Appendix B, Table II, 10 CFR 20. A copy of this report shall be sent to the Manager, AEC New York Operations Office.

d. Surgeon General*

The Surgeon General will be notified immediately by the Radiological Safety Officer by telephone and later by telegraph after it has been determined:

(1) That a probable internal exposure has occurred. In the event that a very hazardous radioisotope such as H^3, Ca^{45}, Fe^{55}, Sr^{90}, Y^{91}, Z^{95}, Ca^{144}, Pm^{147}, Bi^{210}, Ra^{226}, U^{238}, U^{233}, Th^{226}, Po^{210}, Pu^{239}, etc., is involved, the Preventive Medicine Division of the Surgeon General's Office will be contacted immediately by telephone and telegraph.

(2) That 500 millicuries or more of any radioisotope are involved in a fire, expl sion, theft or other loss of control.

(3) That fifty millicuries or more of any moderately hazardous radioisotope such as C^{14}, P^{32}, Na^{22}, S^{35}, Cl^{36}, etc., are involved in a fire, explosion, theft or other loss of control.

(4) That five millicuries or more of any very hazardous radioisotope such as Sr^{90}, Po^{210}, Pu^{239}, Th^{226}, etc., are involved in a fire, explosion, theft or other loss of control.

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* AR 40-582, paragraph 5.

V. DOSIMETRIC METHODS AND RECORDS

1. PHOTODOSIMETRY

a. All personnel present in any "High Radiation Area", "Air-borne Radiation Area" or "Radiation Area" will wear a film badge during such occupancy. In addition, all personnel engaged in the use, handling, storage, or disposal of any amounts of beta, gamma, or neutron-emitting radioisotopes, combinations of materials or equipment capable of emitting X-rays, or any of the above types of radiation will be required to wear a film badge during such operations.

b. The following types of film badges are available upon request:

(1) Body Badge, beta-gamma

(2) Wrist Badge, beta-gamma

(3) Ring Badge, beta-gamma

(4) Body Badge, neutron

c. Lexington Signal Depot, Lexington, Kentucky is responsible for the development and evaluation of photodosimetric film as well as for supplying both the film packet and the film holder.

(1) Beta-Gamma Film Badges

The film components used in the Dupont beta-gamma film packet are 550 and 1290. The components are sealed in a light-tight packet and inserted in a plastic film holder with a "window" and three gamma filters.

The gamma filters consist of:

(a) 0.040 inch of aluminum

(b) 0.040 inch of copper

(c) 0.30 inch of cadmium and 0.010 inch of tungsten

The beta-gamma film packet sensitivity is given in Table III.

TABLE III. BETA-GAMMA FILM PACKET SENSITIVITY

Type of Radiation	Energy, Kev*	Lowest Readable Dose, millirems
Gamma or X-ray	100 or less	2
Gamma or X-ray	100 to 200	10
Gamma or X-ray	200 or above	20
Beta	300 or above	40

* Kev = Kilo electron volt (see Glossary).

The maximum useful range of the film packet for beta, gamma or X-ray radiation is 1,000 rem.

(2) Neutron Film Badges

(a) The Kodak, Type B, neutron film packet is used for neutron detection. The packet is essentially energy-independent over a range from 0.5 to 14 Mev (million electron volt; see Glossary). The packet contains a paper radiator and a thin aluminum shield and is placed in a plastic film holder. The film is evaluated by counting the proton recoil tracks, using a dark field illumination and a 900X magnification and permits reliable readings for dose rates of 100 millirems or greater.

d. Film badges are issued to all personnel working with radioisotopes. The film badges are issued to the individual through the Radiation Area Supervisor.

e. Film badges for visitors may be obtained from the Radiological Safety Section when necessary. The Radiation Area Supervisor will be responsible for supplying the names and organization of visitors to Radiological Safety Section, who will record the radiation exposures as required by regulation.

f. All film badges are changed three times each quarter (two 4-week periods and one 5-week period).

b. Radiological Safety Section will:

(1) Issue film badges and film badge holders to the Radiation Area Supervisors.

(2) Maintain radiation exposure records for each employee as required by AEC.

2. ION CHAMBER DOSIMETRY

a. If persons will be present in areas where radiation dose rate is such that a whole-body exposure of 10 millirem or greater could be received in any one hour, they will be required to wear ion chamber dosimeters, as well as other dosimeters, while in such areas.

b. All ion chamber dosimetric readings will be reported to the Radiological Safety Section and will be recorded with film badge readings.

c. The following types of ion chamber dosimeters are available upon request from the Radiological Safety Section:

Dosimeter Type	Range
Non-self-reading, gamma (limited number)	0 to 200 milliroentgens

3. BIO-ASSAY

a. A physical examination will be made in any case in which an internal or external exposure to ionizing radiation in excess of the maximun permissible dose is either known or suspected and blood counts taken for three consecutive days following the incident and for three weeks at weekly intervals. During this time, the individual will be removed from his occupation and placed under the care of a qualified physician. In all instances of this nature, medical care will be given as soon as possible. The clinical management of all radiation exposure cases will be the responsibility of the Post Surgeon.

b. Where there is a known or suspected internal exposure of any individual to radioactive material, a 24-hour urine sample will immediately be initiated in accordance with AR 40-582.

c. The individual and the urine samples will be transported to Walter Reed Army Medical Center, Washington, D. C., where all necessary bio-assay operations will be performed.

d. A report of the findings of the bio-assay will be sent to the Post Dispensary and a copy of the report will be filed in the personnel exposure records kept in the Radiological Safety Section (See Section V, paragraph 5).

e. Any such exposure will be reported under the provisions of Section IV, paragraph 5, of this manual.

f. Any individual receiving or having a body burden of radioisotopes in excess of the limits listed in National Bureau of Standards Handbook No. 69 "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure" will be removed from an occupation or employment in a radiation area at the recommendation of the Post Surgeon.

4. RADIATION PHYSICAL EXAMINATIONS

a. Initial Physical Examination

(1) Each individual placed on film badge service will be required to take a pre-employment radiation physical examination at the Post Dispensary. The pre-employment physical will consist of the following:

(a) Examination of the skin for exposed wounds, ulcerations, or any pre-cancerous condition.

(b) Complete blood count.

(c) Urinalysis and bio-assay for all individuals who have previously been engaged in the handling of plutonium, uranium, radium, other radioactive rare earths, or hazardous materials that have not been hermetically sealed.

(d) Repeat of the complete blood count within 30 days to establish a normal base line if required by Medical Officer.

(e) Chest X-ray. The Post Dispensary should exempt all individuals on whom a routine chest X-ray has been taken during the past year.

(2) Any of the following findings will disqualify an individual for a radiation occupation or for employment in a radiation area unless exempted by the Post Surgeon:

(a) The presence of exposed wounds, ulcerations, or pre-cancerous conditions of the skin.

(b) Total white blood count of less than 5,000 or above 10,000.

(c) Persistently abnormal leukocyte differential count.

(d) Total red blood count below 3.5 million or above 6.5 million.

(e) Any evidence of previous radiation injury (See Section V, paragraph 5) that is considered disqualifying by the Post Surgeon.

(f) A body burden of radioisotopes in excess of 50 per cent of the amounts specified in paragraph 2.

(g) Any evidence of a chronic or infectious condition of the respiratory tract.

(h) Any evidence of prolonged or continuing radiation therapy treatments.

b. Termination Physical Examinations

A termination physical examination will be given all personnel receiving film badge service upon transfer of duty from Fort Detrick or inactivation from the service. The examinations will be identical to the initial examination.

5. DOSIMETRY RECORD SYSTEMS

a. The Radiological Safety Office will maintain a file of radiation exposure records (DD Form 1141) and of the recommendations of radiation medical examinations. These records will be used as an inspection check of operations.

b. The Post Surgeon will keep the medical records pertaining to individuals that are required by AEC regulations. In addition, exposure records will be maintained by the Post Surgeon of all personnel currently receiving any type of film badge service at Fort Detrick, which will list exposures for a period of ten years under the provisions of AR 40-431 on DD Form 1141.

c. Film badge exposure results are taken from LSD SC 826, which is forwarded to the Radiological Safety Section from Lexington Signal Depot, Lexington, Kentucky, where the photodosimetric film is processed. A copy of the LSD SC 826 results will be sent to the Post Surgeon by the Radiological Safety Section. The films and reports are sent to and from the Depot by air mail.

d. In the event that a photodosimetric film indicates an overexposure, the Lexington Signal Depot will notify the Radiological Safety Section by telephone or TWX, according to the severity of exposure. The Radiological Safety Section will notify the Post Surgeon immediately upon receipt of communication.

e. In instances where an overexposure is known or suspected, the photodosimetric film is sent immediately by air mail to Lexington Signal Depot. The results can usually be obtained within a period of 72 to 96 hours from time of shipment.

VI. TRANSFER, SHIPMENT, STORAGE AND DISPOSAL OF RADIOACTIVE MATERIALS

1. TRANSFER OF RADIOISOTOPES

a. The transfer of radioisotopes from one radiation area or building to another will require that the material be monitored by the Radiological Safety Section prior to the transfer. In addition, a Report of the receipt or transfer of radioactive material will be completed in triplicate. All copies of the form will bear the signature of the individual receiving the radioisotope. The original copy will be sent to the Radiological Safety Section immediately after the transfer has been performed.

b. If the transfer of radioisotopes is to involve activity levels of more than 100 millicuries or more than 10 millicuries in unsealed form, the transfer will be performed with the assistance of Radiological Safety Section.

c. If a transfer of responsibility for any radioisotope is made from one Radiation Area Supervisor to another, the report will be submitted to the Radiological Safety Section.

d. The transfer within the limits of Fort Detrick of radioisotopes not packaged to meet ICC specifications or considered hazardous by the Radiological Safety Section will be escorted by the Radiological Safety Section.

e. Radiological material shall be transferred only to those persons having a valid radiological program to cover the material.

2. RADIOISOTOPE SHIPMENTS TO AND FROM FORT DETRICK

a. Receipts

(1) All receipts of radioisotopes or radioactive material consigned to Fort Detrick will be delivered to the Radiological Safety Section (Bldg. 550). Shipments will be opened by Radiological Safety Section, who will monitor such shipments prior to delivery to the division or branch that requested the material.

(2) In addition, all vehicles carrying radioactive materials into Fort Detrick will be cleared by Radiological Safety Section before leaving.

b. Off-Post Shipments*

(1) Any shipment of radioisotopes from Fort Detrick will be monitored during packaging and prior to shipment by Radiological Safety Section. A written description of the material packaged will be prepared in triplicate by the division shipping the material and signed by the radiation area supervisor or his authorized representative. This letter of description will be in addition to shipping forms required.

(2) In addition to monitoring the shipment, the Radiological Safety Section will check all radioisotope shipments to insure that they meet the requirements of Interstate Commerce Commission and the Atomic Energy Commission Regulations. Table IV lists the maximum external dose level that is permissible for various types and mixtures of radioisotopes to be transported beyond the limits of Fort Detrick.

TABLE IV. MAXIMUM EXTERNAL RADIATION LEVELS FOR RADIOISOTOPE SHIPMENTS

Group (ICC)	Type of Radiation	Maximum Permissible Radiation
I	Radioactive materials that emit gamma rays only or both gamma and electrically charged corpuscular rays	200 mr/hr at surface of the package and 10 mr/hr at one meter
II	Radioactive materials that emit neutrons and either or both types of radiation characteristic of Group I materials	200 mrem/hr at the surface of the package or 10 mrem/hr at one meter
III	Radioactive materials that emit electrically charged corpuscular rays only; i.e., alpha, beta, etc., shielded so that the gamma or X-ray radiation does not exceed the maximum permissible radiation	10 mr/24 hr at the surface of the package

* Agent T.C. George's Tariff No. 13 (ICC Regulations) paragraph 73.391 through 73.396 inclusive.

(3) All packages of radioactive material to be shipped beyond the limits of Fort Detrick will be smear-tested by the Radiological Safety Section prior to shipment. The maximum permissible limits of radioactive contamination will not exceed those prescribed in Section III, paragraph 3, Table II, of this manual. All radioactive materials, except hermetically sealed sources, will be shipped in essentially airtight and watertight containers to prevent possible leakage during shipment.

c. Escort of Off-Post Shipments

If it is impossible or impracticable to package radioactive materials in such a way that they meet the specifications of the Interstate Commerce Commission and/or the Atomic Energy Commission, it is required that these shipments be escorted by the Chemical Corps Technical Escort Unit (Edgewood Arsenal, Md.). In addition, the Radiation Area Supervisor will request a waiver from the regulations from the Radiological Safety Section.

3. STORAGE OF RADIOISOTOPES

a. Storage facilities for radioisotopes must be provided by the using division or branch. Radioactive material will be stored in compliance to CFR Title 10, part 20, paragraph 20.207.

b. The Radiological Safety Section has a limited storage capability for radioactive materials.

4. LOCAL DISPOSAL OF RADIOACTIVE MATERIALS

a. The disposal of radioactive materials at Fort Detrick will be performed by the use of radiological waste containers or by decay wherever possible.

b. Radiological waste containers are available in two types:

(1) Liquid radiological waste containers will be Pyrex glass bottles (carboys) of five-gallon capacity. This container will be marked with a radiation caution symbol (Section III, paragraph 8, Figure 1) and the words "Caution, Radioactive Waste."

(2) Solid radiological waste containers will be metal GI cans in good condition with no leaks and equipped with a metal lid. The drums and lids shall be tagged with the radiation caution symbol and the words "Caution, Radioactive Waste."

c. Radiological waste containers can be obtained from Radiological Safety Section, Ext. 7167.

d. All radiological waste containers, when filled, will be removed and replaced with empty containers by Radiological Safety Section upon request of the responsible investigator, the Radiation Area Supervisor, or their representative.

e. Radiological waste from biologically contaminated areas will be properly sterilized before removal to the clean area by the user.

f. All containers will be tagged by the using agency. The information on the tag will include the radioisotope or radioisotopes with which the waste is contaminated, if known. If the radioisotope is unknown, the type of radiation being emitted will be given.

g. Care shall be taken to insure that only liquid waste is placed in the liquid radiological waste containers. Solid material will not be placed in the liquid containers at any time.

h. Animal cadavers containing any amount of radioactive materials will be disposed of by Radiological Safety Section. Animal cadavers shall be sealed in polyethylene and placed in solid radiological waste containers.

i. Disposal of radioisotopes by storage until the material has decayed for short half-life radioisotopes will not be performed by the user unless approved by the Radiological Safety Section in writing.

5. ULTIMATE DISPOSAL OF RADIOACTIVE MATERIALS

The ultimate disposal of radioisotopes and radioactive waste material at Fort Detrick will be performed under the provisions of AR 755-380.

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Fort Detrick Special Orders Number 60, 25 March 1963, paragraph 1, Amendment to Radioisotope Committee.

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Army Chemical Center Radiation Manual, 15 August 1960.

APPENDIX A

SAMPLE DISPOSITION FORM AND ENDORSEMENTS: RADIOLOGICAL PROGRAM APPROVAL

File Symbol SUBJECT: Request for Approval of Use of Radioisotopes

THRU: Radiological Safety Section FROM: Ch., A. Div. DATE: COMMENT 1
Industrial Health and Safety Division

TO: Fort Detrick Isotope Committee

The following radiological program is submitted for your approval and comment:

a. ABC Branch wishes to use S^{35} for the purpose of studying complex chemical fractions.

b. The amount of S^{35} to be used is 1 mc in the form of sulfide in $Ba(OH)_2$ solution with a concentration of 0.1 mc/ml.

c. One milliliter of the solution will be mechanically placed on a planchet and evaporated to dryness with an infrared lamp.

d. This work will take place in Building 1822, Room 240, using a Class I bacteriological cabinet for the entire operation.

e. Personnel participating in this operation will wear laboratory whites, surgeon's gloves, and film badges.

f. Two GM survey instruments and smear tests counted in a gas proportional counter will be used to insure that no contamination of the laboratory area or operational personnel has occurred.

g. All pertinent rules and precautions given in the Fort Detrick "Radiological Safety Manual" will be observed.

h. Radiological Safety Section will be notified at least one day prior to commencement of the radiological operations.

Radiation Area Supervisor: Dr. E. R. Jones

Responsible Investigator: Mr. O. R. Smith

Operational Personnel: J. R. Lynch

Dr. Emory M. Johnson
Chief, A Division

SAMPLE

SAMPLE

File Symbol
(Date)
SUBJECT: Request for Approval of Use of Radioisotopes

TO: Chairman, Fort Detrick Isotope Committee FROM: Radiological Safety Section Safety Division DATE: COMMENT 2

The subject radiological program has been reviewed, facilities inspected, and approval is recommended. Suggested program number 843.

CHARLES A. GLICK
Chief, Radiological Safety Section

File Symbol
(Date)

TO: Ch., A Division FROM: Fort Detrick Isotope Committee DATE: COMMENT 3

The subject program is designated Radiological Program number 843 and is approved as written.

DR. JOHN B. BAIEMAN
Chairman, Fort Detrick Isotope Committee

GLOSSARY

Accelerator.

A machine or device that imparts kinetic energy to charged particles such as electrons, protons, deuterons, and helium ions.

Alpha Particle (α).

A helium nucleus, consisting of two protons and two neutrons, possessing a double positive charge of 9.5×10^{-10} esu and a mass of 4.00276 amu.

Area (Restricted).

Any laboratory, test field, building, or other location accessible to personnel into which entry is controlled.

Area (Unrestricted).

Any field, laboratory, building, or other location into which entry of personnel is not controlled or any area used for residential quarters.

Area (Radiation).

See Section III, Paragraph 17 of this manual.

Atomic mass unit (amu).

One-sixteenth of the mass of one neutral atom of oxygen-16 equivalent to 0.999728 atomic weight units.

Beta Particle (β).

A charged particle emitted from the nucleus of an atom having a charge of 4.8×10^{-10} esu, which may be either positive or negative, and a mass of 0.000548 amu.

Bio-assay.

The clinical evaluation of a radiation exposure to determine the radiation dose received by an individual.

By-product.

"Any radioactive material or radioisotopes (except special nuclear or source material) yielded in or made radioactive by exposure to radiation incident to the process of producing or utilizing special nuclear material."*

* Code of Federal Regulations, Title 10, Chapter I, Part 20.

Corpuscular Radiation.

The radiation that is made up of particles having a measurable mass such as alpha and beta particles and neutron.

Curie.

The quantity of a radioisotope required to give 3.7×10^{10} disintegrations per second.

Daughter (Decay) Product.

An isotope resulting from the decay of an isotope with an unstable nucleus. It is formed either directly or as a result of successive transformations in the particular radioactive series. A decay product may be either a radioactive or a stable isotope.

Deuterons (H^2).

The nucleus of a heavy isotope of hydrogen containing one proton and one neutron, which has a positive charge of 4.8×10^{-10} esu and a mass of 2.01418 amu.

Dosimeter.

An instrument used to detect and measure an accumulated dose of radiation. The term in common usage means a pencil-sized ionization chamber used in personnel monitoring.

Epilation.

The temporary or permanent loss of the hair.

Erythema.

Reddening of the skin, primarily caused by dilation of the small blood vessels and other tissue damage.

Electron Volt (ev).

A unit of energy acquired by a charged particle carrying a unit electronic charge when it passes through a potential of one volt in a vacuum. It is equivalent to 1.602×10^{-12} erg.

Electrostatic unit of charge (esu).

That quantity of electric charge which, when placed in vacuum one centimeter distant from an equal and like charge, will repel it with a force of one dyne (also termed statcoulomb).

Gamete.

A mature germ cell or reproductive cell such as an ovum or spermatozoon.

Gamma Ray (Y).

A short-wave-length electomagnetic radiation of nuclear origin with a range of wave lengths from about 10^{-8} to 10^{-12} centimeter.

Geiger-Mueller (G-M) Tube.

A gas-filled tube that is operated at sufficiently high voltage to produce avalanche ionization; used in the detection of radiation.

Geiger-Mueller (G-M) Counter.

A radiation detection instrument that uses a Geiger-Mueller tube and an associated electonic circuit to determine the number of incidents of radiation on the tube.

Half-Life.

The amount of time necessary for any particular radioisotope to decay to 50 per cent of its original activity level.

Health Physics.

A term for the branch of radiological science that deals with the protection of individuals from the harmful effects of ionizing radiation.

"Hot" Cell.

An inclosed area, usually equipped with heavy shielding and remote handling equipment, that is used for operations involving radioactive materials having high activity levels.

Ionizing Radiation.

Any electromagnetic or corpuscular radiation capable of producing ions, directly or indirectly, in the material through which it passes.

Kilo Electron Volt (Kev).

One thousand electron volts.

Leak Test.

A term applied to the testing of sealed sources of radioactive material to assure that none of the material is escaping into the environment (See Section III, paragraph 12, of this manual).

Leukocytes.

The white blood cells or corpuscles.

Licensed Radioisotopes (Or Materials).

For the purposes of this manual, the term will refer to radioisotopes that are licensed and controlled by the U.S. Atomic Energy Commission and shall include by-product materials, special nuclear materials, and source materials.

Loss of Control.

When radioisotopes possessed by any user can no longer be controlled or contained by that user.

Maximum Permissible Dose (MPD).

A dose or exposure to ionizing radiation that is not expected to cause detectable bodily harm to an individual for any given period of time, in view of the available knowledge in this field.

Maximum Permissible Exposure.

See Maximum Permissible Dose.

Microcurie (μc).

One-millionth of a curie, or the quantity of a radioisotope required to give 3.7×10^{4} disintegrations per second.

Micro-microcurie (also called picocurie) (μμc).

1×10^{-12} curie or the quantity of a radioisotope required to give 3.7×10^{-2} disintegrations per second.

Millicurie (mc).

One-thousandth of a curie, or the quantity of a radioisotope required to give 3.7×10^{7} disintegrations per second.

Million Electron Volt (Mev).

One million electron volts.

Millirem (mrem).

One thousandth of a rem.

Milliroentgen (mr).

One one-thousandth of a roentgen.

Natural Background.

See Radiation Background.

Neutron Flux.

The number of neutrons per unit time that traverse a sphere of unit cross-sectional area centered about the point of interest. The term is usually expressed in neutrons per square centimeter per second (n/cm^2 / sec).

Neutron Particles (n).

An elementary nuclear particle with a mass of 1.00898 atomic mass units that is electrically neutral:

Fast Neutrons.

Neutrons with energy ranges between 10 kev and 10 mev.

Intermediate Neutrons.

Neutrons with energy ranges between 0.5 ev to 10 kev.

Thermal Neutrons.

Neutrons in thermal equilibrium with their surroundings and those that, for the purposes of this manual, shall be considered to be in the energy range between 0.5 ev and 0.025 ev.

Picocurie (pc).

See Micro-microcurie.

Proton Particle (H^1).

An elementary nuclear particle with a mass of 1.00759 amu and a positive charge of 4.8×10^{-10} esu.

Radiation.

The propagation of energy through space or a material medium in the form of either electromagnetic waves or corpuscular emission. For the purposes of this manual the term shall mean alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed protons and other atomic particles, but not sound waves, radio waves, visible, infrared, or ultraviolet light waves.

Radiation Background.

Radiation detected by radiation detection instruments arising from cosmic rays, natural radioactivity in the area, or radioactive fallout. In general, radiation arising from sources other than those under consideration. This value is not a constant and varies with each instrument and location.

Radiation Dose.

The radiation delivered to a specific area or volume or to the human body. It is usually measured by the amount of energy imparted by ionizing radiation per unit mass at the area or location of interest.

Radiation Dose Rate.

The radiation dose per unit time.

Radioactive Material.

Materials or mixtures of materials that contain unstable atomic nuclei that undergo spontaneous disintegration in which energy is liberated in the form of one or more types of radiation such as alpha particles, beta particles, gamma rays, etc.

Radioactive Decay.

The disintegration of the unstable atomic nucleus by spontaneous emission of radiation, generally resulting in the formation of new isotopes. The rate of radioactive decay is usually expressed in terms of half-life.

Radioactive Contamination.

The disposition of radioisotopes or radioactive materials in any place or on any materials that may constitute a hazard to personnel.

Radiological Spill.

The accidental release of radioisotopes or radioactive materials in any place where they are not desired or where they may constitute a personnel hazard.

Radioisotope.

A species of atom for a given chemical element. It is characterized by an unstable nucleus that undergoes spontaneous disintegration, releasing energy in the form of electromagnetic and/or corpuscular radiation. It is usually denoted by the particular chemical element symbol and its atomic weight.

Roentgen (r).

The quantity of X- or gamma radiation such that the associated corpuscular emission per 0.001293 gram of air produces one esu of ion pairs.

Roentgen Equivalent Man (rem).

The quantity of any type of ionizing radiation that produces, in man, an effect equivalent to one roentgen of X- or gamma radiation.

Scintillation Counter.

The combination of a phosphor, a photomultiplier tube, and the associated electronic circuits for counting light emissions produced in the phosphor by incident radiation.

Sealed Source.

Any radioactive material or radioisotope that is incased in, and is to be used in, a container constructed in such a manner as to prevent the leakage of the radioactive material or radioisotope outside the container.

Smear Test.

The detection of removable radioactive materials or radioisotopes. It is performed by rubbing a small piece of filter paper over approximately 100 centimeters^2 of the surface of some item or area and then counting the paper in a radiation counter. This test is of a qualitative nature only.

Source Material.

All materials except fissionable material that contain by weight 0.05 per cent or more of uranium, thorium, or a combination thereof, as determined by the U.S. Atomic Energy Commission.

Special Nuclear Material.

All radioactive materials, including plutonium, uranium-233, uranium enriched in radioisotope U^{233} or U^{235}, which are determined as special nuclear materials by the U.S. Atomic Energy Commission.

Survey Instrument.

A device used for the detection of radiation or for measuring a radiation field to determine the dose rate within an area.

Total Activity.

The sum of transferable activity and that radioactive contamination that cannot be recovered from an area by smear tests.

Transferable Activity.

Radioactive contamination that may be recovered from an area by smear tests.

24-Hour Urine Sample.

All the urine voided by an individual in a period of 24 hours.

Unsealed Materials.

Radioactive materials or radioisotopes that are not considered to be sealed sources or sealed sources that are leaking.

User.

An individual, agency, or organization that uses, handles, possesses, or stores any amount of radioactive material or radioisotopes.

Wave Radiation.

Electromagnetic radiation that is transmitted through a given medium in wave form. In this manual the term will refer to X- or gamma radiation only.

Wipe Test.

See smear test.

X-Rays.

Penetrating electromagnetic radiations having wavelengths shorter than 50 Angstrom units and usually longer than gamma radiation. X-rays are usually produced by bombarding a metallic target with fast electrons in a vacuum.

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

Statement of considerations. In January 1957 the Commission issued the regulations in this part to establish standards for protection of licensees, their employees and the general public against radiation hazards arising out of the possession or use of special nuclear, source or byproduct material under a license issued by AEC. These regulations among other things, prescribe limitations which govern exposure of personnel to radiation and concentrations of radioactive material, concentrations of radioactive material which may be discharged into air or water, disposal of radioactive wastes; and limits on levels of radiation outside of restricted areas.

The standards established in the regulation were based on those published by the National Committee on Radiation Protection in Handbook 52, "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water," and Handbook 59, "Permissible Dose from External Sources of Ionizing Radiations."

As noted by the Commission in its statement published with Part 20 in the FEDERAL REGISTER (22 F.R. 548, January 29, 1957), "The National Committee on Radiation Protection has under review recommendations to limit cumulative exposures over periods of years. The Commission is giving consideration to appropriate amendments to its regulations to deal with this cumulative exposure problem."

In January 1957, the NCRP issued a preliminary statement containing recommendations with respect to the maximum permissible accumulated dose for occupational radiation exposures, as well as for exposures of the population. These recommendations have since been revised and re-issued as an addendum to National Bureau of Standards Handbook 59, dated April 15, 1958. A complete revision by the NCRP of National Bureau of Standards Handbook 52 on "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water" was published in June 1959 in a new NBS Handbook 69. These changes were announced by the National Bureau of Standards on April 23, 1958.

On May 2, 1959, the Commission published in the FEDERAL REGISTER proposed amendments designed to bring the Commission's radiation protection standards into accord with these most recent recommendations by the NCRP. Many comments and suggestions have been received in response to the notice of proposed rule making. They have been taken into consideration in preparation of the amendment set forth below.

On May 13, 1960, the President approved certain recommendations which had been made to him by the Federal Radiation Council for the guidance of agencies in the executive branch of the Government. The numerical values contained therein are substantially the same as the corresponding values recommended by the NCRP in Handbook 59 (revised) and those incorporated in the following amendments.

The limits on exposure to radiation and concentrations of radioactive material established in the following amendments are based upon available information concerning the biological effects of exposure to radiation from external sources and from concentrations of radioactive material in air and water. The Commission believes that those limits established in the following amendments provide an appropriate regulatory basis for protection of the health and safety of employees and the public without imposing undue burdens upon licensed users of radioactive material.

Recommended limits on exposure, based upon extensive scientific and technical investigation and upon years of experience with the practical problems of radiation protection, represent a consensus as to the measures generally desirable to provide appropriate degrees of safety in the situations to which these measures apply. While the numerical values for exposure limits established in this regulation provide a conservative standard of safety, the nature of the problem is such that lower exposure limits would be used if considered practical. At the same time, if there were sufficient reason, the use of considerably higher exposure limits in this regulation would not have been considered to result in excessive hazards.

The Commission recognizes that guides and recommendations based upon these considerations cannot be converted into regulations without loss of flexibility in applying the recommendations to individual situations. It is, however, the policy of the Commission to minimize this loss of flexibility both in the formulation of its regulations and in their administration to the greatest extent compatible with the nature of the problem and with good regulatory practice.

Literal application of the NCRP and Federal Radiation Council (FRC) standards to individuals who have had prior occupational exposure to radiation requires a determination of the magnitude of previous exposures. Such a determination in many situations may be extremely and unnecessarily burdensome. Frequently, records of previous exposures will be unavailable or available only at great inconvenience and expense. In many cases previous occupational exposures to sources of ionizing radiation beyond the Commission's jurisdiction will not have been recorded. Hence, in formulating the following amendments it has appeared desirable to permit continued exposure to the low levels of radiation specified in paragraph (a) of § 20.101 without regard to previous occupational exposure. The limits established in paragraph (a) of § 20.101 would permit occupational exposure to the whole body, gonads and blood-forming organs over a period of a year not exceeding one-third the annual exposure to radiation previously permitted under the existing Part 20 regulations. This rate corresponds also to the average annual exposure which may be accumulated under the NCRP and FRC recommendations. It is believed likely that a good many licensees will prefer to limit the occupational exposure of their employees to this level rather than undertake the burden and expense of determining individual previously accumulated exposures from past records.

In any case where a licensee desires to take advantage of any additional exposure (3 rems per quarter whole body exposure) under the NCRP and FRC recommendations, the licensee may do so pursuant to paragraph (b) of § 20.101 of the amendments.

One of the problems considered in connection with the amendments concerns persons who for any reason might receive an exposure to radiation or concentrations of radioactive material in excess of the established limits. Such exposures would, of course, be contrary to the Commission's regulations and might in appropriate cases be made the subject of appropriate proceedings against the licensee by the Commission. Rigid application of the "limits" on exposure might, in some cases, lead to unwarranted removal of the individual from employment involving radiation exposure and consequent periods of unemployment. The regulation, however, does not adopt such an approach. The additional risk to an individual as the result of further radiation exposure within the limits prescribed in the amendments is believed to be sufficiently small that, except in rare situations, removal from employment after an ac-

oidental over-exposure would not be warranted. Under the amendments, licensees will be required to notify the individual, as well as the Commission, of any exposure to radiation above the limits established. It should be noted that where an individual receives radiation exposure in excess of the limits prescribed for any calendar period (calendar quarter in the case of exposure to radiation, week in the case of exposure to radioactive material), he must be removed from further exposure during the remainder of the applicable period. The regulations require that in determining the accumulated dose of any individual under paragraph (b) of § 20.101, previous over-exposures must be included.

The amendments include a comprehensive revision of the values specified in Appendix B, "Concentrations in Air and Water above Natural Background." The values specified in those tables are the concentrations to which licensees may expose persons in restricted areas, or which may be released by licensees into the environment, without specific approval from the Commission. With respect to most isotopes listed, the principal differences between the values set forth in the new tables and those contained in Appendix B of the regulation published in January 1957 are a reduction to one-third of the concentrations of those radioisotopes having their principal effect upon the gonads or the whole body (i.e., those as to which the "whole body" or the gonads are considered to be the critical organs) and lowering of others to control the exposure to the gastrointestinal tract to 15 rems per year.

The reductions in the values specified in Appendix B do not modify the basic approach in Part 20 with respect to levels of radiation and concentrations of radioactive materials in unrestricted areas. The sections limit levels of radiation and concentrations of radioactive material which may be created in unrestricted areas by licensees, without special authorization from the AEC, to specified low levels. These levels are believed to be sufficiently low to provide reasonable assurance that individuals in unrestricted areas will not receive a dose to the whole body in any period of one year in excess of 0.5 rem. Procedures are incorporated in those sections, as previously, under which the Commission may authorize licensees in specific cases to create higher levels in unrestricted areas where the circumstances of the particular case are such as to provide reasonable assurance that individuals in the unrestricted areas will not receive a dose to the whole body in any period of one year in excess of 0.5 rem.

Authority is reserved to the Commission in § 20.108 to require the furnishing of appropriate bio-assay services where necessary or desirable in order to determine the extent of an individual's exposure to radioactive material.

The amendments do not require licensees to calculate a "combined" exposure for employees who receive occupational exposure to internal as well as external radiation. Knowledge of the relative effects of exposure to internal and external radiation, and means for calculating "combined" exposures, are not sufficiently well developed for this to be a workable procedure. As a practical matter, it would be rare for an individual to receive an organ dose in excess of the limits recommended by the FRC as a result of "combined" exposure from external and internal sources. In any event, observance of the limits on internal exposure and the limits on external exposure will restrict the dose to any organ to a maximum of two times the value recommended by the Federal Radiation Council.

The amendments require licensees to furnish reports to employees of exposure to radiation and concentrations of radioactive material in excess of the limits specified in the amendments. Licensees are also required to furnish periodic exposure information to employees if requested by them. Forms are incorporated in the regulation for recording of occupational exposures and exposure histories which should be of considerable assistance to licensees in complying with the regulations and to the Commission in its enforcement program.

The adoption of the limits specified in these amendments should not be considered as a departure from the principle that unnecessary exposure to ionizing radiation should be avoided.

The following is a summary of some of the principal differences between the amendment set forth below and the proposed amendment published in May 1958:

(a) The table of neutron flux dose equivalents in paragraph (c), § 20.4 has been amended to bring it up-to-date with values specified in NCRP Handbook No. 63.

(b) Criteria for measuring concentrations of radon and its decay products, natural uranium, and natural thorium have been revised (paragraphs (b) and (c) of § 20.5).

(c) Paragraph (c) of § 20.102 has been substantially revised. As published below, it will require any licensee who proposes to expose an employee to radiation within the limits of the accumulated dose formula specified in § 20.101(b) to make reasonable attempts to obtain reports of the employee's previous occupational exposure to radiation. It also specifies the occupational dose which must be assumed for any calendar quarter of occupational exposure to radiation for which the licensee is unable to obtain such reports. The values specified for this purpose, as to periods after the effective date of these amendments, have been lowered from 3 rem (whole body exposure) to 1¼ rem. Corresponding reductions have been made for other parts of the body. The new values are the same as the values to which employees may be exposed without obtaining records of previous exposure.

(d) The provisions in § 20.103 applicable to exposure of individuals to concentrations of radioactive material in restricted areas have been modified. The modifications are for the purpose of making it clear that, in determining whether individuals are being exposed in restricted areas to concentrations of radioactive material within the limits specified, no credit should be taken for particle size or the use of respirators or similar equipment unless approved by the Commission. A paragraph has been added to this section specifying the kinds of information which should be submitted to the Commission to obtain such approvals.

(e) Reference to body burdens of radioactive material has been deleted from § 20.108 and from Appendix B. Control of internal exposure is accomplished in the regulation by limiting the concentrations of radioactive material in air and water to which employees may be exposed. Section 20.108 in the amendments provides that in appropriate, specific cases the Commission may require that bio-assay studies be conducted.

(f) Changes have been made in the radiation levels specified in paragraph (a), of § 20.202. This paragraph establishes requirements concerning the use of personnel monitoring equipment. The new values are high enough to be susceptible of measurement by personnel monitoring equipment which is in general use. At the same time, they are low enough to assure that any exposure to substantial portions of the permitted doses under the regulations will be recorded.

(g) Section 20.206 has been revised to require that a copy of the regulations in this part, and of operating procedures incorporated as a condition of applicable licenses, be posted or kept available for examination upon request. In addition, § 20.206 now requires that employers post conspicuously a new form of poster intended to inform employees of the requirements in this part, their right to request information concerning their exposure to radiation, and similar matters.

(h) Changes have been made in the record keeping requirements (§ 20.401) to eliminate two of the record forms which would have been required under the proposed amendments. The information which would have been required by the deleted forms has been incorporated in a simplified Form AEC–5.[1]

(i) Clarifying revisions have been made in § 20.403 pertaining to reports to the Commission of incidents. This section defines incidents that must be reported to the Commission either immediately or within twenty-four hours. The circumstances under which such reports must be furnished to the Commission under the following amendments have been redefined so as to make them consistent with the revised limits on exposure to radiation established by the amendments.

(j) The provisions of the proposed rules published in May 1958 requiring reports to individuals of exposure to radiation have been simplified and reduced. Section 20.404, requiring reports to employees of exposure to radiation upon termination of employment, is now

[1] Filed as part of the original document.

applicable only if the employee requests such a report. The provisions in § 20.406 have been revised to require that employees be notified annually of their exposure to radiation only upon request of the employee. In addition, the provision has been redrafted so as to eliminate the need for licensees to furnish this information to employees in the form of a report or other similar document. Section 20.406 requires that the licensee "advise" the employee of such exposure. Under the provisions, the licensee may furnish the information to the employee in any appropriate way, e.g., orally, or otherwise. Section 20.405 retains, without substantial change, the requirement that if there is an exposure of an individual to radiation or to radioactive material in excess of any limit in the regulations or the applicable license, the exposure must be reported both to the Commission and to the individual exposed.

The Atomic Energy Commission's regulation 10 CFR Part 20 is hereby republished for the purpose of incorporating into one document all amendments to the regulation to date, including the amendment published in the FEDERAL REGISTER on September 7, 1960, and the errata published in the FEDERAL REGISTER on October 27, 1960, to become effective January 1, 1961.

The following Statement of Consideration was published in 25 F.R. 13953, December 30, 1960, in connection with some further amendments to 10 CFR 20.

On September 7, 1960, the Commission published in the FEDERAL REGISTER amendments to 10 CFR Part 20 to become effective January 1, 1961. The amendments were designed to bring the Commission's radiation protection standards into accord with the most recent recommendations of the Federal Radiation Council and the National Committee on Radiation Protection and Measurements. Subsequent to publication of the amendments on September 7, 1960, the Commission has received several comments from interested parties requesting clarification and corrections of certain sections of the regulation. The following amendments are designed to clarify and correct the regulation in the following respects:

1. Section 20.3(a)(4) of the regulation permits licensees to determine calendar quarters either (1) as successive 3-month calendar periods starting on January 1 of a year or (2) as successive periods of 13 complete consecutive weeks starting with the first complete calendar week of the year. Film badge processors have indicated that method (1) of determining calendar quarters would present problems to the industry in that every user of film badges on a monthly basis would be required to start his use on the first day of each month, thereby resulting a large influx of badges to be processed at that time of the month with only a few badges during the balance of the month. They have indicated that method (2) of determining calendar quarters is also unsatisfactory in that users of film badges on a two-week calendar basis could not keep records for a 13-week calendar quarter. Since the purpose of the regulation in defining a calendar quarter is limited to assuring that the exposure of individuals during a period of approximately 3 months is restricted to specified amounts, § 20.3(a)(4)(1) is amended to permit 3-month "calendar quarters" to start on any date within January, April, July or October rather than only on the first of the month; and to permit "calendar quarters" determined on a weekly basis to consist of alternating 14-week and 12-week periods, rather than only 13-week periods.

2. Section 20.206(c) requires Form AEC-3, (Notice to Employees), to be posted in every establishment where licensed activities are carried on regardless of whether any restricted areas which require radiation protection control measures exist in such establishment. Some licensees have pointed out that this requirement is unduly burdensome since posting of a Notice in unrestricted areas will result in many employees not working in restricted areas, nor even engaged in work with licensed material, becoming needlessly concerned as to the applicability of the poster to their activities. Since the purpose of the Notice is solely to assure that an employee working in or frequenting a restricted area would be made aware of the information contained in the poster, § 20.206(c) is amended to require posting in such locations as to assure that employees working in or frequenting restricted areas will observe the Notice on the way to or from work.

3. Section 20.3(a)(14) of the regulation defines "Restricted area" in part as any area access to which is controlled by the licensee. Some licensees have requested clarification of the definition since access is controlled to many areas which have no relation to radioactive material. The definition has been changed by adding the phrase "for purposes of protection of individuals from exposure to radiation and radioactive materials". A corresponding change has been made in the definition of an unrestricted area in § 20.3(a)(17).

4. The Appendix "B" note in the regulation specifies methods of general applicability for determining limits for concentrations where there is a mixture in air or water of more than one radionuclide. It was not contemplated that these methods would necessarily apply in determining concentration limits for unique complex mixtures such as uranium ore dust. The concentration limit for the mixture of radionuclides in uranium ore dust calculated in accordance with these methods is lower by a factor of about 4 than previous concentration limits used for uranium ore dust. The uranium mill licensees have questioned the applicability of the Appendix "B" note methods for deriving a limit for uranium ore dust. The reduction in the limit for uranium ore dust is due to the fractional contribution of the unusually low limit for the radionuclide Thorium-230. The limit for Thorium-230 is based on a retention half-time in the lung of 4 years for pure thorium compounds. However, Thorium-230 does not appear in uranium ore dust as pure thorium compounds. The radionuclides in uranium ore dust of major health concern consist primarily of particles of insoluble uranium, which account for about 99.99 percent of the radionuclides with respect to mass, in secular equilibrium with the daughter products Thorium-230 and Radium-226 which are probably interspersed in a matrix within the uranium particle. Because of the unique physical and chemical state of the mixture of radionuclides in uranium ore dust, it does not appear appropriate to use the retention time for pure Thorium-230 as the basis for establishing a limit for ore dust. Rather, it appears desirable to use a single retention time for the mixture based upon the characteristics of the dust particle in which the radionuclides are fixed in insoluble form.

Accordingly, Appendix "B" note has been modified by adding paragraph 4 to establish concentration limits which are specifically applicable to uranium ore dust in air. It is assumed in deriving the new limits that the retention half-life of the individual radionuclides are governed not by their individual characteristics in the pure chemical state but by the characteristics of the dust particles in which the radionuclides are contained. For this purpose, a half-life of 120 days is used. This follows the practice of the International Commission on Radiological Protection and the National Committee on Radiation Protection in using a 120 day half-life for all insoluble materials in the lung except thorium and plutonium. This problem is under study by the Commission and by the Federal Radiation Council and the limits specified should be considered interim values pending the result of such studies. Appropriate revisions will be made in the limits if the studies indicate a need therefor.

Inasmuch as these amendments are intended to relieve from rather than to impose restrictions under regulations currently in effect and will not adversely affect the public health and safety, the Commission has found that general notice of proposed rule-making and public procedure thereon are unnecessary and good cause exists why these amendments should be made effective as of January 1, 1961, the effective date of previously published amendments to Part 20.

GENERAL PROVISIONS

PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

PRECAUTIONARY PROCEDURES

WASTE DISPOSAL

RECORDS, REPORTS, AND NOTIFICATION

EXCEPTIONS AND ADDITIONAL REQUIREMENTS

ENFORCEMENT

AUTHORITY: §§ 20.1 to 20.601 issued under sec. 161, 68 Stat. 948, as amended; 42 U.S.C. 2201.

SOURCE: §§ 20.1 to 20.601 appear at 25 F.R. 10915, Nov. 17, 1960, except as otherwise noted.

GENERAL PROVISIONS

§ 20.1 *Purpose.* (a) The regulations in this part establish standards for protection against radiation hazards arising out of activities under licenses issued by the Atomic Energy Commission and are issued pursuant to the Atomic Energy Act of 1954 (68 Stat. 919).

(b) The use of radioactive material or other sources of radiation not licensed by the Commission is not subject to the regulations in this part. However, it is the purpose of the regulations in this part to control the possession, use, and transfer of licensed material by any licensee in such a manner that exposure to such material and to radiation from such material, when added to exposures to unlicensed radioactive material and to other unlicensed sources of radiation in the possession of the licensee, and to radiation therefrom, does not exceed the standards of radiation protection prescribed in the regulations in this part.

§ 20.2 *Scope.* The regulations in this part apply to all persons who receive, possess, use or transfer byproduct material, source material, or special nuclear material under a general or specific license issued by the Commission pursuant to the regulations in Part 30, 40, or 70 of this chapter.

§ 20.3 *Definitions.* (a) As used in this part:

(1) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto;

(2) "Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases;

(3) "Byproduct material" means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

(4) "Calendar quarter" means any period determined according to either of the following subdivisions:

(i) The first period of any year may begin on any date in January; provided that the second, third and fourth periods accordingly begin on the same date in April, July, and October, respectively, and that the fourth period extend into January of the succeeding year, if necessary to complete a three-month quarter. During the first year of use of this method of determination by a licensee, the first period for that year shall also include any additional days in January preceding the starting date for the first period.

[Amended]

CHANGE: § 20.3(a)(4)(i) amended to read as set forth above at 25 F.R. 13953, Dec. 30, 1960.

(ii) The first period in a calendar year of 13 complete, consecutive calendar weeks; the second period in a calendar year of 13 complete, consecutive calendar weeks; the third period in a calendar year of 13 complete, consecutive calendar weeks; the fourth period in a calendar year of 13 complete, consecutive calendar weeks. Alternatively, the four periods may consist of the first 14 complete, consecutive calendar weeks; the next 12 complete, consecutive calendar weeks; the next 14 complete, consecutive calendar weeks; and the last 12 complete, consecutive calendar weeks. If at the end of a calendar year there are any days not falling within a complete calendar week of that year, such days shall be included (for purposes of this part) within the last complete calendar week of that year. If at the beginning of any calendar year there are days not falling within a complete calendar week of that year, such days shall be included (for purposes of this part) within the last complete calendar week of the previous year.

[Amended]

CHANGE: § 20.3(a)(4)(ii) amended by adding second sentence at 25 F.R. 13953 Dec. 30, 1960.

No licensee shall change the method observed by him of determining calendar quarters for purposes of this part except at the beginning of a calendar year.

(5) "Commission" means the Atomic Energy Commission or its duly authorized representatives;

(6) "Government agency" means any executive department, commission, independent establishment, corporation, wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government;

(7) "Individual" means any human being;

(8) "Licensed material" means source material, special nuclear material, or byproduct material received, possessed, used, or transferred under a general or specific license issued by the Commission pursuant to the regulations in this chapter;

(9) "License" means a license issued under the regulations in Part 30, 40, or 70 of this chapter. "Licensee" means the holder of such license;

(10) "Occupational dose" includes exposure of an individual to radiation (i) in a restricted area; or (ii) in the course of employment in which the individual's duties involve exposure to radiation; provided, that "occupational dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.

(11) "Person" means (i) any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission, any State, any foreign government or nation or any political subdivision of any such government or nations, or other entity; and (ii) any legal successor, representative, agent, or agency of the foregoing;

(12) "Radiation" means any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light;

(13) "Radioactive material" includes any such material whether or not subject to licensing control by the Commission;

(14) "Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area;

[Amended]

CHANGE: § 20.3(14) amended by adding after the word "licensee" in the first sentence "for purposes of protection of individuals from exposure to radiation and radioactive materials" at 25 F.R. 13953, Dec. 30, 1960.

(15) Source material" means (i) uranium or thorium, or any combination thereof, in any physical or chemical form or (ii) ores which contain by weight one-twentieth of one percent (0.05%) or more of a. uranium, b. thorium or c. any combination thereof. Source material does not include special nuclear material.

[Amended]

SOURCE: § 20.3(a)(15) amended as set forth above at 27 F.R. 5905, June 22, 1962.

(16) "Special nuclear material" means (1) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or (ii) any material artificially enriched by any of the foregoing but does not include source material;

(17) "Unrestricted area" means any area access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

[Amended]

CHANGES: § 20.3(17) amended after the word "area" by substituting "access to" for "entry into" and by adding after "licensee" the phrase "for purposes of protection of individuals from exposure to radiation and radioactive materials" at 25 F.R. 13953, Dec. 30, 1960.

(b) Definitions of certain other words and phrases as used in this part are set forth in other sections, including:

(1) "Airborne radioactivity area" defined in § 20.203;

(2) "Radiation area" and "high radiation area" defined in § 20.202;

(3) "Personnel monitoring equipment" defined in § 20.202;

(4) "Survey" defined in § 20.201;

(5) Units of measurement of dose (rad, rem) defined in § 20.4;

(6) Units of measurement of radioactivity defined in § 20.5.

§ 20.4 *Units of radiation dose.* (a) "Dose," as used in this part, is the quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body. When the regulations in this part specify a dose during a period of time, the dose means the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of time. Several different units of dose are in current use. Definitions of units as used in this part are set forth in paragraphs (b) and (c) of this section.

(b) The rad, as used in this part, is a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue. (One millirad (mrad) =0.001 rad.)

(c) The rem, as used in this part, is a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one roentgen (r) of X-rays. (One millirem (mrem) =0.001 rem.) The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions of irradiation. For the purpose of the regulations in this part, any of the following is considered to be equivalent to a dose of one rem:

(1) A dose of 1 r due to X— or gamma radiation;

(2) A dose of 1 rad due to X—, gamma or beta radiation;

(3) A dose of 0.1 rad due to neutrons or high energy protons;

(4) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye;

If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, as provided in subparagraph (3) of this paragraph, one rem of neutron radiation may, for purposes of the regulations in this part, be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

NEUTRON FLUX DOSE EQUIVALENTS

Neutron energy (Mev)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm²)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm² per sec)
Thermal	970×10^6	670
0.0001	720×10^6	500
0.005	820×10^6	570
0.02	400×10^6	280
0.1	130×10^6	90
0.5	41×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	25×10^6	18
7.5	24×10^6	17
10	24×10^6	17
10 to 30	14×10^6	10

(d) For determining exposures to X or gamma rays up to 3 Mev, the dose limits specified in §§ 20.101 to 20.104, inclusive, may be assumed to be equivalent to the "air dose". For the purpose of this part "air dose" means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of highest dosage rate.

§ 20.5 *Units of radioactivity.* (a) Radioactivity is commonly, and for purposes of the regulations in this part shall be, measured in terms of disintegrations per unit time or in curies. One curie (c) = 3.7×10^{10} disintegrations per second (dps) = 2.2×10^{12} disintegrations per minute (dpm). A commonly used submultiple of the curie is the microcurie (μc). One μc = 0.000001 c = 3.7×10^4 dps = 2.2×10^6 dpm.

(b) For purposes of the regulations in this part, it may be assumed that the daughter activity concentrations in the following table are equivalent to an air concentration of 10^{-7} microcuries of Radon 222 per milliliter of air in equilibrium with the daughters RaA, RaB, RaC, and RaC':

Maximum time between collection and measurement (hours)[1]	Alpha-emitting daughter activity collected per milliliter of air	
	Microcuries	Total alpha disintegrations per minute per cc
0.5	7.2×10^{-8}	0.16
1	4.5×10^{-8}	0.10
2	1.9×10^{-8}	0.042
3	0.3×10^{-8}	0.0072

[1] The duration of sample collection and the duration of measurement should be sufficiently short compared to the time between collection and measurement, as not to have a statistically significant effect upon the results.

(c) *Natural uranium and natural thorium.* (1) For purposes of the regulations in this part, one curie of natural uranium (U-natural in Appendix B or C) means the sum of 3.7×10^{10} disintegrations per second from U-238 plus 3.7×10^{10} dis/sec from U-234 plus 9×10^8 dis/sec from U-235. Also, a curie of natural thorium (thorium-natural in Appendix B or C) means the sum of 3.7×10^{10} dis/sec from Th^{232} plus 3.7×10^{10} dis/sec from Th^{228}.

(2) For the purpose of the regulations in this part, one curie of natural uranium (U-natural in Appendix B or C) is equivalent to 3,000 kilograms, or 6,615 pounds of natural uranium; and one curie of natural thorium (thorium-natural in Appendix B or C) is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

§ 20.6 *Interpretations.* Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the commission.

§ 20.7 *Communications.* All communications and reports concerning the regulations in this part, and applications filed under them, should be addressed to the Atomic Energy Commission, Washington 5, D.C., Attention: Division of Licensing and Regulation. Communications and reports may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C., or its offices at Germantown, Md.

§ 20.101 *Exposure of individuals to radiation in restricted areas.* (a) Except as provided in paragraph (b) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of the limits specified in the following table:

Rems per calendar quarter	
1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	1¼
2. Hands and forearms; feet and ankles	18¾
3. Skin of whole body	7½

(b) A licensee may permit an individual in a restricted area to receive a dose to the whole body greater than that permitted under paragraph (a) of this section, provided:

(1) During any calendar quarter the dose to the whole body from radioactive material and other sources of radiation in the licensee's possession shall not exceed 3 *rems; and*

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (*N*–18) rems where "*N*" equals the individual's age in years at his last birthday; and

(3) The licensee has determined the individual's accumulated occupational dose to the whole body on Form AEC–4, or on a clear and legible record containing all the information required in that form; and has otherwise complied with the requirements of § 20.102. As used in paragraph (b), "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

§ 20.102 *Determination of accumulated dose.* (a) This section contains requirements which must be satisfied by licensees, who propose, pursuant to paragraph (b) of § 20.101, to permit individuals in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101.

(b) Before permitting any individual in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101, each licensee shall:

(1) Obtain a certificate on Form AEC–4, or on a clear and legible record containing all the information required in that form, signed by the individual showing each period of time after the individual attained the age of 18 in which the individual received an occupational dose of radiation; and

(2) Calculate on Form AEC–4 in accordance with the instructions appearing therein, or on a clear and legible record containing all the information required in that form, the previously accumulated occupational dose received by the individual and the additional dose allowed for that individual under § 20.101(b).

(c)(1) In the preparation of Form AEC–4, or a clear and legible record containing all the information required in that form, the licensee shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the licensee obtains such reports, the licensee shall use the dose shown in the report in preparing the form. In any case where a licensee is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

Part of body	Column 1 Assumed exposure in rems for calendar quarters prior to Jan. 1, 1961	Column 2 Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye	3¼	1¼

(2) The licensee shall retain and preserve records used in preparing Form AEC–4.

If calculation of the individual's accumulated occupational dose for all periods prior to January 1, 1961 yields a result higher than the applicable accumulated dose value for the individual as of that date, as specified in paragraph (b) of § 20.101, the excess may be disregarded.

§ 20.103 *Exposure of individuals to concentrations of radioactive material in restricted areas.* (a) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual in a restricted area to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table I, of this part. "Expose" as used in this section means that the individual is present in an airborne concentration. No allowance shall be made for the use of protective clothing or equipment, or particle size, except as authorized by the Commission pursuant to paragraph (c) of this section.

(b) The limits given in Appendix B, Table I, of this part are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be increased proportionately. In any such period where the number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

(c)(1) Except as authorized by the Commission pursuant to this paragraph, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits specified in Appendix B, Table I.

(2) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the concentration is composed in whole or in part of particles of such size that such particles are not respirable, and that the individual will not inhale the concentrations in excess of the limits established in Appendix B, Table I. Each application under this subparagraph shall include an analysis of particle sizes in the concentrations; and a description of the methods used in determining the particle sizes.

(3) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and that the individual will not inhale, ingest or absorb quantities of radioactive material in excess of those which might otherwise be permitted under this part for employees in restricted areas during a 40-hour week. Each application under this subparagraph shall contain the following information:

(i) A description of the protective equipment to be employed, including the efficiency of the equipment for the material involved;

(ii) Procedures for the fitting, maintenance and cleaning of the protective equipment; and

(iii) Procedures governing the use of the protective equipment, including supervisory procedures and length of time the equipment will be used by the individuals in each work week. The proposed periods for use of the equipment by any individual should not be of such duration as would discourage observance by the individual of the proposed procedures; and

(iv) The average concentrations present in the areas occupied by employees.

§ 20.104 *Exposure of minors.* (a) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual within a restricted area who is under 18 years of age, to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of 10 percent of the limits specified in the table in paragraph (a) of § 20.101.

(b) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual within a restricted area, who is under 18 years of age to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table II of this part. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

(c) The provisions of paragraph (c) of § 20.103, shall apply to exposures subject to paragraph (b) of this section.

§ 20.105 *Permissible levels of radiation in unrestricted areas.* (a) There may be included in any application for a license or for amendment of a license proposed limits upon levels of radiation in unrestricted areas resulting from the applicant's possession or use of radioactive material and other sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted

area involved. The Commission will approve the proposed limits if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem.

(b) Except as authorized by the Commission pursuant to paragraph (a) of this section, no licensee shall possess, use or transfer licensed material in such a manner as to create in any unrestricted area from radioactive material and other sources of radiation in his possession:

(1) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour, or

(2) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

§ 20.106 *Concentrations in effluents to unrestricted areas.* (a) There may be included in any application for a license or for amendment of a license proposed limits upon concentrations of licensed and other radioactive material released into air or water in unrestricted areas as a result of the applicant's proposed activities. Such applications should include information as to anticipated average concentrations and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that it is not likely that any individual will be exposed to concentrations in excess of the limits specified in Appendix B, Table II, of this part. For purposes of this paragraph concentrations may be averaged over periods not greater than one year.

(b) Except as authorized by the Commission pursuant to § 20.302 or paragraph (a) of this section, no licensee shall possess, use or transfer licensed material in such a manner as to release into air or water in any unrestricted area any concentration of radioactive material in excess of the limits specified in Appendix B, Table II, of this part. For purposes of this paragraph, concentrations may be averaged over periods not greater than one year.

(c) For purposes of this section, determinations as to the concentration of radioactive material shall be made with respect to the point where such material leaves the restricted area. Where the radioactive material is discharged through a stack, tube, pipe, or similar conduit, the determination may be made with respect to the point where the material leaves such conduit.

(d) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems (see § 20.303).

§ 20.107 *Medical diagnosis and therapy.* Nothing in the regulations in this part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or medical therapy.

§ 20.108 *Orders requiring furnishing of bio-assay services.* Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the Commission may incorporate appropriate provisions in any license, directing the licensee to make available to the individual appropriate bio-assay services and to furnish a copy of the reports of such services to the Commission.

PRECAUTIONARY PROCEDURES

§ 20.201 *Surveys.* (a) As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

(b) Each licensee shall make or cause to be made such surveys as may be necessary for him to comply with the regulations in this part.

§ 20.202 *Personnel monitoring.* (a) Each licensee shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(1) Each individual who enters a restricted area under such circumstances that he receives or is likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in paragraph (a) of § 20.101.

(2) Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in paragraph (a) of § 20.101.

(3) Each individual who enters a high radiation area.

(b) As used in this part.

(1) "Personnel monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.);

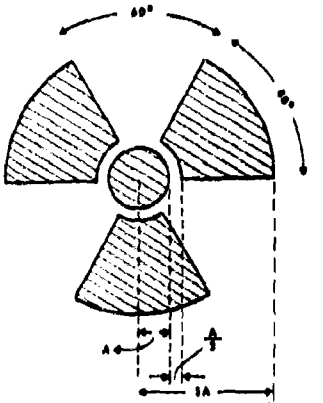
(2) "Radiation area" means any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 100 millirems;

(3) "High radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

§ 20.203 *Caution signs, labels, and signals.* (a) *General.* (1) Except as otherwise authorized by the Commission, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-bladed design:

RADIATION SYMBOL

1. Cross-hatched area is to be magenta or purple.
2. Background is to be yellow.



(2) In addition to the contents of signs and labels prescribed in this section, licensees may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation or to radioactive material.

(b) *Radiation areas.* Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION [1]
RADIATION AREA

(c) *High radiation areas.* (1) Each high radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION [1]
HIGH RADIATION AREA

(2) Each high radiation area shall be equipped with a control device which shall either cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirem in one hour upon entry into the area or shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the licensee or a supervisor of the activity are made aware of the entry. In the case of a high radiation area established for a period of 30 days or less, such control device is not required.

(d) *Airborne radioactivity areas.* (1) As used in the regulations in this part, "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations in excess of the amounts specified in Appendix B, Table I, Column 1, of this part; or

[1] Or "Danger".

(ii) any room, enclosure, or operating area in which airborne radioactive material composed wholly or partly of licensed material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix B, Table I, Column 1, of this part.

(2) Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[1]

AIRBORNE RADIOACTIVITY AREA

(c) *Additional requirements.* (1) Each area or room in which licensed material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in an amount exceeding 10 times the quantity of such material specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[1]

RADIOACTIVE MATERIAL(S)

(2) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding one-hundred times the quantity specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[1]

RADIOACTIVE MATERIAL(S)

(f) *Containers.* (1) Each container in which is transported, stored, or used a quantity of any licensed material (other than natural uranium or thorium) greater than the quantity of such material specified in Appendix C of this part shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION[1]

RADIOACTIVE MATERIAL

(2) Each container in which natural uranium or thorium is transported, stored, or used in a quantity greater than ten times the quantity specified in Appendix C of this part shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION[1]

RADIOACTIVE MATERIAL

(3) Notwithstanding the provisions of subparagraphs (1) and (2) a label shall not be required:

(i) If the concentration of the material in the container does not exceed that specified in Appendix B, Table I, Column 2, of this part, or

(ii) For laboratory containers, such as beakers, flasks, and test tubes, used transiently in laboratory procedures, when the user is present.

(4) Where containers are used for storage, the labels required in this paragraph shall state also the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

[1] Or "Danger".

§ 20.204 *Exceptions from posting requirements.* Notwithstanding the provisions of § 20.203,

(a) A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level twelve inches from the surface of the source container or housing does not exceed five millirem per hour.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs because of the presence of patients containing byproduct material provided that there are personnel in attendance who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in the regulations in this part.

(c) *Caution signs are not required to* be posted at areas or rooms containing radioactive materials for periods of less than eight hours provided that (1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in the regulations in this part and; (2) such area or room is subject to the licensee's control.

§ 20.205 *Exemptions for radioactive materials packaged for shipment.* Radioactive materials packaged and labeled in accordance with regulations of the Interstate Commerce Commission shall be exempt from the labeling and posting requirements of § 20.203 during shipment, provided that the inside containers are labeled in accordance with the provisions of § 20.203(f).

§ 20.206 *Instruction of personnel; posting of notices to employees.* (a) All individuals working in or frequenting any portion of a restricted area shall be informed of the occurrence of radioactive materials or of radiation in such portions of the restricted area; shall be instructed in the safety problems associated with exposure to such materials or radiation and in precautions or procedures to minimize exposure; shall be instructed in the applicable provisions of Commission regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials; and shall be advised of reports of radiation exposure which employees may request pursuant to these regulations.

(b) Each licensee shall post a current copy of the regulations in this part, a copy of the license, and a copy of operating procedures applicable to work under the license conspicuously in a sufficient number of places in every establishment where employees are employed in activities licensed by the Commission to permit them to observe such documents on the way to or from their place of employment or shall keep such documents available for employees' examination upon request.

(c) Form AEC-3, "Notice to Employees", shall be conspicuously posted in a sufficient number of places in every establishment where employees are employed in activities licensed by the Commission to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

[Amended]

CHANGE: § 20.206(c) amended after the word "permit" by deleting the word "them" and substituting therefor the phrase "employees working in or frequenting any portion of a restricted area" at 25 F.R. 13953, Dec. 30, 1960.

NOTE: Copies of Form AEC-3, "Notice to Employees," may be obtained by writing to the Director of the appropriate Atomic Energy Commission Regional Compliance Office listed in Appendix "D" or the Director, Division of Licensing and Regulation, USAEC, Washington 25, D.C.

[Amended]

SOURCE: The note following § 20.206(c) amended to read as set forth above at 27 F.R. 5905, June 22, 1962.

§ 20.207 *Storage of licensed materials.* Licensed materials stored in an unrestricted area shall be secured against unauthorized removal from the place of storage.

WASTE DISPOSAL

§ 20.301 *General requirement.* No licensee shall dispose of licensed material except:

(a) By transfer to an authorized recipient as provided in the regulations in Part 30, 40, or 70 of this chapter, whichever may be applicable; or

(b) As authorized pursuant to § 20.302; or

(c) As provided in § 20.303 or § 20.304, applicable respectively to the disposal of licensed material by release into sanitary sewerage systems or burial in soil, or in § 20.106 (Concentrations in Effluents to Unrestricted Areas).

§ 20.302 *Method for obtaining approval of proposed disposal procedures.* Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

The Commission will not approve any application for a license to receive licensed material from other persons for disposal on land not owned by the Federal government or by a State government.

[Amended]

CHANGE: § 20.302 amended by adding last paragraph as above at 26 F.R. 352, Jan. 18, 1961.

§ 20.303 *Disposal by release into sanitary sewerage systems.* No licensee shall discharge licensed material into a sanitary sewerage system unless:

(a) It is readily soluble or dispersible in water; and

(b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of subparagraphs (1) or (2) of this paragraph:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration equal to the limits specified in Appendix B, Table I, Column 2, of this part; or

(2) Ten times the quantity of such material specified in Appendix C of this part; and

(c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix B, Table I, Column 2, of this part; and

(d) The gross quantity of licensed and other radioactive material released into the sewerage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

§ 20.304 *Disposal by burial in soil.* No licensee shall dispose of licensed material by burial in soil unless:

(a) The total quantity of licensed and other radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix C of this part; and

(b) Burial is at a minimum depth of four feet; and

(c) Successive burials are separated by distances of at least six feet and not more than 12 burials are made in any year.

§ 20.305 *Treatment or disposal by incineration.* No licensee shall treat or dispose of licensed material by incineration except as specifically approved by the Commission, pursuant to §§ 20.106 (a) and 20.302.

RECORDS, REPORTS, AND NOTIFICATION

§ 20.401 *Records of surveys, radiation monitoring, and disposal.* (a) Each licensee shall maintain records showing the radiation exposures of all individuals for whom personnel monitoring is required under § 20.202 of the regulations in this part. Such records shall be kept on Form AEC–5, in accordance with the instructions contained in that form or on clear and legible records containing all the information required by Form AEC–5. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

(b) Each licensee shall maintain records in the same units used in the appendices to this part, showing the results of surveys required by § 20.201(b), and disposals made under §§ 20.302, 20.303, and 20.304.

(c) Records of individual radiation exposure which must be maintained pursuant to the provisions of this subsection shall be preserved until December 31, 1965 or until a date five years after termination of the individual's employment, whichever is later. Records which must be maintained pursuant to this part may be maintained in the form of microfilms.

NOTE: Prior to December 31, 1965, the Commission may amend this paragraph to assure the further preservation of records which it determines should not be destroyed.

§ 20.402 *Reports of theft or loss of licensed material.* Each licensee shall report by telephone and telegraph to the Director of the appropriate Atomic Energy Commission Regional Compliance Office listed in Appendix D, immediately after its occurrence becomes known to the licensee, any loss or theft of licensed material in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

[Amended]

SOURCE: § 20.402 amended to read as set forth above at 27 F.R. 5905, June 22, 1962.

§ 20.403 *Notifications of incidents.* (a) *Immediate notification.* Each licensee shall immediately notify the Director of the appropriate Atomic Energy Commission Regional Compliance Office shown in Appendix D by telephone and telegraph of any incident involving byproduct, source or special nuclear material possessed by him and which may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual of 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II; or

(3) A loss of one working week or more of the operation of any facilities affected; or

(4) Damage to property in excess of $100,000.

(b) *Twenty-four hour notification.* Each licensee shall within 24 hours notify the Director of the appropriate Atomic Energy Commission Regional Compliance Office listed in Appendix D by telephone and telegraph of any incident involving licensed material possessed by him and which may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix B, Table II; or

(3) A loss of one day or more of the operation of any facilities affected; or

(4) Damage to property in excess of $1,000.

[Amended]

SOURCE: § 20.403 (a) and (b) amended to read as set forth above at 27 F.R. 5905, June 22, 1962.

(c) Any report filed with the Commission pursuant to this section shall be prepared so that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

[Added]

SOURCE: Paragraph (c) of § 20.403 added at 28 F.R. 6822, Jul. 3, 1963. *Effective* Sept. 1, 1963.

§ 20.404 *Report to former employees of exposure to radiation.* At the request of a former employee each licensee shall furnish to the former employee a report of the former employee's exposure to radiation as shown in records maintained by the licensee pursuant to § 20.401(a). Such report shall be furnished within 30 days from the time the request is made; shall cover each calendar quarter of the individual's employment involving exposure to radiation, or such lesser period as may be requested by the employee. The report shall also include the results of any calculations and analyses of radioactive material deposited in the body of the employee and made pursuant to the provisions of § 20.108. The report shall be in writing and contain the following statement:

This report is furnished to you under the provisions of the Atomic Energy Commission regulations entitled "Standards for Protection Against Radiation" (10 CFR Part 20). You should preserve this report for future reference.

(b) The former employee's request should include appropriate identifying data, such as social security number and dates and locations of employment.

§ 20.405 *Reports of overexposures and excessive levels and concentrations.* (a) In addition to any notification required by § 20.403, each licensee shall make a report in writing within 30 days to the Director, Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C., with a copy to the Director of the appropriate Atomic Energy Commission Regional Compliance Office listed in Appendix D, of (1) each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit in this part or in the licensee's license; (2) any incident for which notification is required by § 20.403; and (3) levels of radiation or concentrations of radioactive material (not involving excessive exposure of any individual) in an unrestricted area in excess of ten times any applicable limit set forth in this part or in the licensee's license. Each report required under this paragraph shall describe the extent of exposure of persons to radiation or to radioactive material; levels of radiation and concentrations of radioactive mate-

rial involved; the cause of the exposure, levels or concentrations; and corrective steps taken or planned to assure against a recurrence.

[Amended]

SOURCE: § 20.405(a) amended to read as set forth above at 27 F.R. 5905, June 22, 1962.

(b) In any case where a licensee is required pursuant to the provisions of this section to report to the Commission any exposure of an individual to radiation or to concentrations of radioactive material, the licensee shall also notify such individual of the nature and extent of exposure. Such notice shall be in writing and shall contain the following statement:

This report is furnished to you under the provisions of the Atomic Energy Commission regulations entitled "Standards for Protection Against Radiation" (10 CFR Part 20). You should preserve this report for future reference.

(c) Any report filed with the Commission pursuant to this section shall be prepared so that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

[Added]

SOURCE: Paragraph (c) of § 20.405 added at 28 F.R. 6822, Jul. 3, 1963. *Effective* Sept. 1, 1963.

§ 20.406. ***Notice to employees of exposure to radiation.*** At the request of any employee, each licensee shall advise such employee annually of the employee's exposure to radiation as shown in records maintained by the licensee pursuant to § 20.401(a).

EXCEPTIONS AND ADDITIONAL REQUIREMENTS

§ 20.501 ***Applications for exemptions.*** The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

§ 20.502 ***Additional requirements.*** The Commission may, by rule, regulation, or order, impose upon any licensee such requirements, in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

ENFORCEMENT

§ 20.601 ***Violations.*** An injunction or other court order may be obtained prohibiting any violation of any provision of the act or any regulation or order issued thereunder. Any person who willfully violates any provision of the act or any regulation or order issued thereunder may be guilty of a crime, and upon conviction, may be punished by fine or imprisonment or both, as provided by law.

APPENDIX A [Reserved]

APPENDIX B

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See notes at end of appendix]

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Actinium (89)	Ac 227	S	2×10⁻¹²	6×10⁻³	8×10⁻¹⁴	2×10⁻⁴
		I	3×10⁻¹²	9×10⁻³	9×10⁻¹³	3×10⁻⁴
	Ac 228	S	8×10⁻⁹	3×10⁻³	3×10⁻¹⁰	9×10⁻⁵
		I	2×10⁻⁸	6×10⁻³	6×10⁻¹⁰	2×10⁻⁴
Americium (95)	Am 241	S	6×10⁻¹²	1×10⁻⁴	2×10⁻¹³	4×10⁻⁶
		I	1×10⁻¹¹	3×10⁻⁴	4×10⁻¹³	1×10⁻⁵
	Am 242m	S	6×10⁻¹²	1×10⁻⁴	2×10⁻¹³	4×10⁻⁶
		I	1×10⁻¹¹	3×10⁻⁴	4×10⁻¹³	1×10⁻⁵
	Am 243	S	1×10⁻¹²	4×10⁻⁵	4×10⁻¹⁴	1×10⁻⁶
		I	1×10⁻¹¹	3×10⁻⁴	4×10⁻¹³	1×10⁻⁵
Antimony (51)	Sb 122	S	2×10⁻⁷	8×10⁻³	6×10⁻⁹	2×10⁻⁴
		I	1×10⁻⁷	5×10⁻³	4×10⁻⁹	1×10⁻⁴
	Sb 124	S	2×10⁻⁷	7×10⁻³	5×10⁻⁹	2×10⁻⁴
		I	2×10⁻⁷	7×10⁻³	7×10⁻⁹	2×10⁻⁴
	Sb 125	S	5×10⁻⁷	2×10⁻²	2×10⁻⁸	6×10⁻⁴
		I	3×10⁻⁷	1×10⁻²	1×10⁻⁸	4×10⁻⁴
Argon (18)	A 37	Sub[2]	6×10⁻³	----------	1×10⁻⁴	----------
	A 41	Sub	2×10⁻⁶	----------	4×10⁻⁸	----------
Arsenic (33)	As 73	S	2×10⁻⁶	1×10⁻²	7×10⁻⁸	5×10⁻⁴
		I	4×10⁻⁷	1×10⁻²	1×10⁻⁸	5×10⁻⁴
	As 74	S	3×10⁻⁷	1×10⁻²	1×10⁻⁸	5×10⁻⁴
		I	1×10⁻⁷	5×10⁻³	4×10⁻⁹	2×10⁻⁴
	As 76	S	1×10⁻⁷	4×10⁻³	4×10⁻⁹	1×10⁻⁴
		I	1×10⁻⁷	4×10⁻³	3×10⁻⁹	1×10⁻⁴
	As 77	S	5×10⁻⁷	2×10⁻²	2×10⁻⁸	7×10⁻⁴
		I	4×10⁻⁷	2×10⁻²	1×10⁻⁸	5×10⁻⁴
Astatine (85)	At 211	S	7×10⁻⁹	3×10⁻³	2×10⁻¹⁰	9×10⁻⁵
		I	3×10⁻⁸	1×10⁻²	1×10⁻⁹	4×10⁻⁴
Barium (56)	Ba 131	S	1×10⁻⁶	5×10⁻³	4×10⁻⁸	2×10⁻⁴
		I	4×10⁻⁷	1×10⁻²	1×10⁻⁸	4×10⁻⁴
	Ba 140	S	1×10⁻⁷	8×10⁻⁴	4×10⁻⁹	2×10⁻⁵
		I	4×10⁻⁸	1×10⁻³	1×10⁻⁹	4×10⁻⁵
Berkelium (97)	Bk 249	S	9×10⁻¹⁰	3×10⁻⁴	3×10⁻¹¹	1×10⁻⁵
		I	1×10⁻⁹	4×10⁻⁴	4×10⁻¹¹	1×10⁻⁵
Beryllium (4)	Be 7	S	1×10⁻⁶	5×10⁻³	4×10⁻⁸	2×10⁻⁴
		I	1×10⁻⁶	5×10⁻³	4×10⁻⁸	2×10⁻⁴
Bismuth (83)	Bi 206	S	2×10⁻⁷	1×10⁻³	6×10⁻⁹	4×10⁻⁵
		I	1×10⁻⁷	1×10⁻³	5×10⁻⁹	4×10⁻⁵
	Bi 207	S	2×10⁻⁷	2×10⁻³	6×10⁻⁹	6×10⁻⁵
		I	1×10⁻⁷	2×10⁻³	5×10⁻⁹	6×10⁻⁵
	Bi 210	S	6×10⁻⁹	2×10⁻³	2×10⁻¹⁰	6×10⁻⁵
		I	6×10⁻⁹	1×10⁻³	2×10⁻¹⁰	4×10⁻⁵
	Bi 212	S	1×10⁻⁷	1×10⁻³	5×10⁻⁹	4×10⁻⁵
		I	2×10⁻⁷	1×10⁻³	7×10⁻⁹	4×10⁻⁵
Bromine (35)	Br 82	S	1×10⁻⁶	8×10⁻³	4×10⁻⁸	3×10⁻⁴
		I	2×10⁻⁶	1×10⁻²	6×10⁻⁸	4×10⁻⁴
Cadmium (48)	Cd 109	S	5×10⁻⁸	5×10⁻³	2×10⁻⁹	2×10⁻⁴
		I	7×10⁻⁸	5×10⁻³	3×10⁻⁹	2×10⁻⁴
	Cd 115m	S	4×10⁻⁸	7×10⁻⁴	1×10⁻⁹	3×10⁻⁵
		I	4×10⁻⁸	7×10⁻⁴	1×10⁻⁹	3×10⁻⁵
	Cd 115	S	2×10⁻⁷	1×10⁻³	8×10⁻⁹	3×10⁻⁵
		I	2×10⁻⁷	1×10⁻³	6×10⁻⁹	4×10⁻⁵
Calcium (20)	Ca 45	S	3×10⁻⁸	3×10⁻⁴	1×10⁻⁹	1×10⁻⁵
		I	1×10⁻⁷	5×10⁻³	4×10⁻⁹	2×10⁻⁴
	Ca 47	S	2×10⁻⁷	1×10⁻³	6×10⁻⁹	3×10⁻⁵
		I	2×10⁻⁷	1×10⁻³	6×10⁻⁹	4×10⁻⁵
Californium (98)	Cf 249	S	2×10⁻¹²	1×10⁻⁴	5×10⁻¹⁴	4×10⁻⁶
		I	2×10⁻¹²	1×10⁻⁴	5×10⁻¹⁴	4×10⁻⁶
	Cf 250	S	1×10⁻¹¹	7×10⁻⁴	3×10⁻¹³	2×10⁻⁵
		I	5×10⁻¹²	4×10⁻⁴	2×10⁻¹³	1×10⁻⁵
	Cf 252	S	1×10⁻¹¹	7×10⁻⁴	3×10⁻¹³	2×10⁻⁵
		I	2×10⁻¹¹	7×10⁻⁴	7×10⁻¹³	2×10⁻⁵
Carbon (6)	C 14	S	1×10⁻⁶	7×10⁻³	4×10⁻⁸	2×10⁻⁴
	(CO₂)	Sub[3]	4×10⁻⁶	2×10⁻³	1×10⁻⁷	5×10⁻⁴
	C 14 (CO)	Sub	5×10⁻⁴	----------	1×10⁻⁶	----------
Cerium (58)	Ce 141	S	4×10⁻⁷	3×10⁻³	2×10⁻⁸	9×10⁻⁵
		I	2×10⁻⁷	3×10⁻³	5×10⁻⁹	9×10⁻⁵
	Ce 143	S	3×10⁻⁷	1×10⁻³	9×10⁻⁹	4×10⁻⁵
		I	2×10⁻⁷	1×10⁻³	7×10⁻⁹	4×10⁻⁵
	Ce 144	S	1×10⁻⁸	3×10⁻⁴	3×10⁻¹⁰	1×10⁻⁵
		I	6×10⁻⁸	3×10⁻⁴	2×10⁻¹⁰	1×10⁻⁵
Cesium (55)	Cs 131	S	1×10⁻⁶	7×10⁻³	4×10⁻⁸	2×10⁻⁴
		I	3×10⁻⁶	9×10⁻³	1×10⁻⁷	3×10⁻⁴
	Cs 134m	S	4×10⁻⁶	2×10⁻²	1×10⁻⁷	6×10⁻⁴
		I	6×10⁻⁶	3×10⁻²	2×10⁻⁷	1×10⁻³
	Cs 134	S	4×10⁻⁶	3×10⁻³	1×10⁻⁷	9×10⁻⁵
		I	1×10⁻⁶	1×10⁻³	4×10⁻¹⁰	4×10⁻⁵
	Cs 135	S	5×10⁻⁷	3×10⁻³	2×10⁻⁸	1×10⁻⁴
		I	9×10⁻⁷	7×10⁻³	3×10⁻⁸	2×10⁻⁴
Cesium (55)	Cs 136	S	4×10⁻⁷	2×10⁻³	1×10⁻⁸	9×10⁻⁵
		I	2×10⁻⁷	7×10⁻³	6×10⁻⁹	2×10⁻⁴
	Cs 137	S	6×10⁻⁶	4×10⁻³	2×10⁻⁸	2×10⁻⁴
		I	1×10⁻⁶	1×10⁻³	5×10⁻¹⁰	4×10⁻⁵
Chlorine (17)	Cl 36	S	4×10⁻⁷	2×10⁻³	1×10⁻⁸	8×10⁻⁵
		I	2×10⁻⁷	2×10⁻³	9×10⁻⁹	6×10⁻⁵
	Cl 38	S	3×10⁻⁶	1×10⁻²	9×10⁻⁸	4×10⁻⁴
		I	2×10⁻⁶	1×10⁻²	7×10⁻⁸	4×10⁻⁴
Chromium (24)	Cr 51	S	1×10⁻⁶	5×10⁻²	4×10⁻⁸	2×10⁻³
		I	2×10⁻⁶	5×10⁻²	9×10⁻⁸	2×10⁻³
Cobalt (27)	Co 57	S	3×10⁻⁶	2×10⁻²	1×10⁻⁷	5×10⁻⁴
		I	2×10⁻⁶	1×10⁻²	6×10⁻⁸	4×10⁻⁴
	Co 58m	S	5×10⁻⁶	3×10⁻²	2×10⁻⁷	1×10⁻³
		I	4×10⁻⁶	2×10⁻²	1×10⁻⁷	6×10⁻⁴
	Co 58	S	9×10⁻⁷	6×10⁻³	3×10⁻⁸	2×10⁻⁴
		I	6×10⁻⁷	4×10⁻³	2×10⁻⁸	1×10⁻⁴
	Co 60	S	5×10⁻⁷	3×10⁻³	2×10⁻⁸	9×10⁻⁵
		I	3×10⁻⁷	1×10⁻³	1×10⁻⁸	5×10⁻⁵
Copper (29)	Cu 64	S	9×10⁻⁷	1×10⁻²	3×10⁻⁸	4×10⁻⁴
		I	2×10⁻⁶	1×10⁻²	7×10⁻⁸	3×10⁻⁴
Curium (96)	Cm 242	S	1×10⁻⁶	6×10⁻³	4×10⁻⁸	2×10⁻⁴
		I	1×10⁻¹⁰	7×10⁻⁴	4×10⁻¹²	2×10⁻⁵
	Cm 243	S	2×10⁻¹²	7×10⁻⁴	6×10⁻¹⁴	3×10⁻⁶
		I	6×10⁻¹²	1×10⁻³	2×10⁻¹³	5×10⁻⁶
	Cm 244	S	1×10⁻¹²	7×10⁻⁴	3×10⁻¹⁴	2×10⁻⁵
		I	9×10⁻¹²	2×10⁻³	3×10⁻¹³	7×10⁻⁵
	Cm 245	S	1×10⁻¹²	8×10⁻⁴	3×10⁻¹⁴	3×10⁻⁵
		I	5×10⁻¹²	1×10⁻³	2×10⁻¹³	4×10⁻⁵
	Cm 246	S	1×10⁻¹²	8×10⁻⁴	4×10⁻¹⁴	3×10⁻⁵
		I	5×10⁻¹²	1×10⁻³	2×10⁻¹³	4×10⁻⁵
Dysprosium (66)	Dy 165	S	1×10⁻⁷	8×10⁻³	4×10⁻⁹	3×10⁻⁴
		I	3×10⁻⁶	1×10⁻²	9×10⁻⁸	4×10⁻⁴
	Dy 166	S	2×10⁻⁶	1×10⁻²	7×10⁻⁸	4×10⁻⁴
		I	2×10⁻⁷	1×10⁻²	8×10⁻⁹	4×10⁻⁴
Erbium (68)	Er 169	S	2×10⁻⁷	1×10⁻²	7×10⁻⁹	4×10⁻⁴
		I	6×10⁻⁷	3×10⁻²	2×10⁻⁸	9×10⁻⁴
	Er 171	S	4×10⁻⁷	3×10⁻³	1×10⁻⁸	9×10⁻⁵
		I	7×10⁻⁷	3×10⁻³	2×10⁻⁸	1×10⁻⁴
Europium (63)	Eu 152 (T½=9.2 hrs)	S	6×10⁻⁷	3×10⁻²	2×10⁻⁸	1×10⁻³
		I	4×10⁻⁷	2×10⁻²	1×10⁻⁸	6×10⁻⁴
	Eu 152 (T½=13 yrs)	S	3×10⁻⁷	2×10⁻³	1×10⁻⁸	6×10⁻⁵
		I	1×10⁻⁶	2×10⁻³	4×10⁻¹⁰	8×10⁻⁵
	Eu 154	S	2×10⁻⁷	2×10⁻³	6×10⁻⁹	8×10⁻⁵
		I	4×10⁻⁸	6×10⁻⁴	1×10⁻⁹	2×10⁻⁵
	Eu 155	S	7×10⁻⁸	6×10⁻⁴	2×10⁻⁹	2×10⁻⁵
		I	9×10⁻⁸	6×10⁻⁴	3×10⁻⁹	2×10⁻⁵
Fluorine (9)	F 18	S	7×10⁻⁶	6×10⁻³	3×10⁻⁸	2×10⁻⁴
		I	5×10⁻⁶	2×10⁻³	2×10⁻⁷	8×10⁻⁵
Gadolinium (64)	Gd 153	S	3×10⁻⁶	1×10⁻²	9×10⁻⁸	5×10⁻⁴
		I	2×10⁻⁷	6×10⁻³	8×10⁻⁹	2×10⁻⁴
	Gd 159	S	9×10⁻⁷	6×10⁻³	3×10⁻⁸	2×10⁻⁴
		I	5×10⁻⁷	2×10⁻³	2×10⁻⁸	8×10⁻⁵
Gallium (31)	Ga 72	S	4×10⁻⁷	2×10⁻³	1×10⁻⁸	8×10⁻⁵
		I	2×10⁻⁷	1×10⁻³	8×10⁻⁹	4×10⁻⁵
Germanium (32)	Ge 71	S	2×10⁻⁷	1×10⁻³	6×10⁻⁹	4×10⁻⁵
		I	1×10⁻⁶	5×10⁻³	4×10⁻⁸	2×10⁻⁴
Gold (79)	Au 196	S	6×10⁻⁶	5×10⁻³	2×10⁻⁷	2×10⁻⁴
		I	1×10⁻⁶	5×10⁻³	4×10⁻⁸	2×10⁻⁴
	Au 198	S	6×10⁻⁷	4×10⁻³	2×10⁻⁸	1×10⁻⁴
		I	3×10⁻⁷	2×10⁻³	1×10⁻⁸	5×10⁻⁵
	Au 199	S	2×10⁻⁶	1×10⁻²	8×10⁻⁸	4×10⁻⁴
		I	2×10⁻⁶	1×10⁻²	8×10⁻⁸	4×10⁻⁴

See footnotes at end of table.

APPENDIX B—Continued

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

[See notes at end of appendix]

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Gold (79)	Au 199	S	1×10⁻⁶	5×10⁻⁶	4×10⁻⁶	2×10⁻⁵
		I	8×10⁻⁷	4×10⁻⁶	3×10⁻⁶	2×10⁻⁵
Hafnium (72)	Hf 181	S	4×10⁻⁶	2×10⁻⁵	1×10⁻⁵	7×10⁻⁵
		I	7×10⁻⁶	2×10⁻⁵	3×10⁻⁶	7×10⁻⁵
Holmium (67)	Ho 166	S	2×10⁻⁷	9×10⁻⁶	7×10⁻⁶	3×10⁻⁵
		I	2×10⁻⁷	9×10⁻⁶	7×10⁻⁶	3×10⁻⁵
Hydrogen (1)	H3	S	5×10⁻⁶	1×10⁻³	2×10⁻⁷	3×10⁻⁵
		Sub	2×10⁻⁵	.....	4×10⁻⁶	.....
Indium (49)	In 113m	S	8×10⁻⁶	4×10⁻⁵	3×10⁻⁷	1×10⁻⁵
		I	7×10⁻⁶	4×10⁻⁵	2×10⁻⁷	1×10⁻⁵
	In 114m	S	1×10⁻⁷	5×10⁻⁶	4×10⁻⁹	2×10⁻⁷
		I	2×10⁻⁶	5×10⁻⁶	7×10⁻¹⁰	2×10⁻⁷
	In 115m	S	2×10⁻⁶	1×10⁻⁵	8×10⁻⁹	4×10⁻⁷
		I	2×10⁻⁶	1×10⁻⁵	6×10⁻⁹	4×10⁻⁷
	In 115	S	2×10⁻⁷	3×10⁻⁶	9×10⁻⁹	9×10⁻⁸
		I	3×10⁻⁶	3×10⁻⁶	1×10⁻⁸	9×10⁻⁸
Iodine (53)	I 126	S	8×10⁻⁹	5×10⁻⁶	3×10⁻¹⁰	2×10⁻⁶
		I	3×10⁻⁷	3×10⁻⁶	1×10⁻⁸	9×10⁻⁸
	I 129	S	2×10⁻⁹	1×10⁻⁶	6×10⁻¹¹	4×10⁻⁷
		I	7×10⁻⁹	6×10⁻⁶	2×10⁻⁸	2×10⁻⁷
	I 131	S	9×10⁻⁹	6×10⁻⁶	3×10⁻¹⁰	2×10⁻⁶
		I	3×10⁻⁷	2×10⁻⁶	1×10⁻⁸	6×10⁻⁸
	I 132	S	2×10⁻⁷	2×10⁻⁵	8×10⁻⁹	6×10⁻⁷
		I	9×10⁻⁷	5×10⁻⁶	3×10⁻⁸	2×10⁻⁷
	I 133	S	3×10⁻⁸	2×10⁻⁶	1×10⁻⁹	7×10⁻⁸
		I	2×10⁻⁷	1×10⁻⁶	7×10⁻⁹	4×10⁻⁸
	I 134	S	5×10⁻⁷	4×10⁻⁵	2×10⁻⁸	1×10⁻⁶
		I	3×10⁻⁶	2×10⁻⁵	1×10⁻⁷	6×10⁻⁷
	I 135	S	1×10⁻⁷	7×10⁻⁶	4×10⁻⁹	2×10⁻⁷
		I	4×10⁻⁷	2×10⁻⁵	1×10⁻⁸	7×10⁻⁷
Iridium (77)	Ir 190	S	1×10⁻⁶	6×10⁻⁶	4×10⁻⁸	2×10⁻⁷
		I	4×10⁻⁷	5×10⁻⁶	1×10⁻⁸	2×10⁻⁷
	Ir 192	S	1×10⁻⁷	1×10⁻⁵	4×10⁻⁹	4×10⁻⁷
		I	3×10⁻⁶	1×10⁻⁵	9×10⁻⁹	4×10⁻⁷
	Ir 194	S	2×10⁻⁷	1×10⁻⁵	8×10⁻⁹	3×10⁻⁷
		I	2×10⁻⁷	9×10⁻⁶	5×10⁻⁹	3×10⁻⁷
Iron (26)	Fe 55	S	8×10⁻⁶	2×10⁻⁵	3×10⁻⁶	8×10⁻⁶
		I	1×10⁻⁶	7×10⁻⁶	3×10⁻⁸	2×10⁻⁷
	Fe 59	S	3×10⁻⁷	2×10⁻⁶	5×10⁻⁹	6×10⁻⁸
		I	5×10⁻⁶	2×10⁻⁵	2×10⁻⁸	5×10⁻⁸
Krypton [3] (36)	Kr 85m	Sub	6×10⁻⁶	.....	1×10⁻⁶	.....
	Kr 85	Sub	1×10⁻⁵	.....	3×10⁻⁶	.....
	Kr 87	Sub	1×10⁻⁶	.....	2×10⁻⁷	.....
Lanthanum (57)	La 140	S	2×10⁻⁷	7×10⁻⁶	5×10⁻⁹	2×10⁻⁷
		I	1×10⁻⁷	7×10⁻⁶	4×10⁻⁹	2×10⁻⁷
Lead (82)	Pb 203	S	3×10⁻⁶	1×10⁻⁵	9×10⁻⁹	4×10⁻⁷
		I	2×10⁻⁶	1×10⁻⁵	6×10⁻⁹	4×10⁻⁷
	Pb 210	S	1×10⁻¹⁰	4×10⁻⁶	4×10⁻¹²	1×10⁻⁷
		I	2×10⁻¹⁰	5×10⁻⁶	8×10⁻¹²	2×10⁻⁷
	Pb 212	S	2×10⁻⁶	6×10⁻⁶	6×10⁻⁹	2×10⁻⁷
		I	2×10⁻⁶	5×10⁻⁶	7×10⁻⁹	2×10⁻⁷
Lutetium (71)	Lu 177	S	6×10⁻⁷	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
		I	5×10⁻⁷	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
Manganese (25)	Mn 52	S	2×10⁻⁷	1×10⁻⁵	7×10⁻⁹	5×10⁻⁷
		I	1×10⁻⁷	9×10⁻⁶	5×10⁻⁹	3×10⁻⁷
	Mn 54	S	4×10⁻⁷	4×10⁻⁵	1×10⁻⁸	1×10⁻⁶
		I	4×10⁻⁷	3×10⁻⁵	1×10⁻⁸	1×10⁻⁶
	Mn 56	S	8×10⁻⁷	4×10⁻⁵	3×10⁻⁸	1×10⁻⁶
		I	5×10⁻⁷	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
Mercury (80)	Hg 197m	S	2×10⁻⁷	6×10⁻⁶	5×10⁻⁹	2×10⁻⁷
		I	8×10⁻⁷	5×10⁻⁶	3×10⁻⁸	2×10⁻⁷
	Hg 197	S	1×10⁻⁶	9×10⁻⁶	4×10⁻⁸	3×10⁻⁷
		I	3×10⁻⁶	1×10⁻⁵	9×10⁻⁸	4×10⁻⁷
	Hg 203	S	7×10⁻⁷	2×10⁻⁶	2×10⁻⁸	6×10⁻⁸
		I	1×10⁻⁶	3×10⁻⁶	4×10⁻⁸	1×10⁻⁷
Molybdenum (42)	Mo 99	S	7×10⁻⁷	7×10⁻⁶	3×10⁻⁸	2×10⁻⁷
		I	2×10⁻⁶	1×10⁻⁵	6×10⁻⁸	4×10⁻⁷
Neodymium (60)	Nd 144	S	8×10⁻¹¹	2×10⁻⁵	1×10⁻¹²	7×10⁻⁷
		I	3×10⁻⁷	2×10⁻⁵	8×10⁻⁹	6×10⁻⁷
	Nd 147	S	4×10⁻⁷	2×10⁻⁵	1×10⁻⁸	6×10⁻⁷
		I	2×10⁻⁷	2×10⁻⁵	8×10⁻⁹	6×10⁻⁷
	Nd 149	S	2×10⁻⁶	8×10⁻⁶	6×10⁻⁸	3×10⁻⁷
		I	1×10⁻⁶	8×10⁻⁶	5×10⁻⁸	3×10⁻⁷
Neptunium (93)	Np 237	S	4×10⁻¹¹	1×10⁻⁵	1×10⁻¹²	3×10⁻⁷
		I	1×10⁻⁶	9×10⁻⁶	4×10⁻⁸	3×10⁻⁷
	Np 239	S	8×10⁻⁷	4×10⁻⁵	3×10⁻⁸	1×10⁻⁶
		I	7×10⁻⁷	4×10⁻⁵	2×10⁻⁸	1×10⁻⁶
Nickel (28)	Ni 59	S	2×10⁻⁶	2×10⁻⁵	9×10⁻⁸	6×10⁻⁷
		I	8×10⁻⁷	2×10⁻⁵	3×10⁻⁸	6×10⁻⁷
	Ni 63	S	6×10⁻⁶	8×10⁻⁶	2×10⁻⁷	3×10⁻⁷
		I	2×10⁻⁶	8×10⁻⁶	7×10⁻⁸	3×10⁻⁷
	Ni 65	S	9×10⁻⁷	4×10⁻⁵	3×10⁻⁸	1×10⁻⁶
		I	5×10⁻⁷	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
Niobium (Columbium) (41)	Nb 93m	S	1×10⁻⁷	1×10⁻⁵	4×10⁻⁹	4×10⁻⁷
		I	2×10⁻⁷	1×10⁻⁵	7×10⁻⁹	4×10⁻⁷
	Nb 95	S	5×10⁻⁷	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
		I	1×10⁻⁶	3×10⁻⁵	4×10⁻⁸	1×10⁻⁶
	Nb 97	S	6×10⁻⁶	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
		I	5×10⁻⁶	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
Osmium (76)	Os 185	S	5×10⁻⁷	2×10⁻⁵	2×10⁻⁸	7×10⁻⁷
		I	5×10⁻⁷	2×10⁻⁵	2×10⁻⁸	7×10⁻⁷
	Os 191m	S	2×10⁻⁶	7×10⁻⁵	5×10⁻⁸	2×10⁻⁶
		I	9×10⁻⁶	7×10⁻⁵	3×10⁻⁷	2×10⁻⁶
	Os 191	S	1×10⁻⁶	5×10⁻⁶	4×10⁻⁸	2×10⁻⁷
		I	4×10⁻⁶	5×10⁻⁶	1×10⁻⁷	2×10⁻⁷

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Osmium (76)	Os 193	S	4×10⁻⁷	2×10⁻⁶	1×10⁻⁸	6×10⁻⁸
		I	3×10⁻⁷	2×10⁻⁶	9×10⁻⁹	6×10⁻⁸
Palladium (46)	Pd 103	S	1×10⁻⁶	1×10⁻⁵	5×10⁻⁸	3×10⁻⁷
		I	7×10⁻⁷	8×10⁻⁶	3×10⁻⁸	3×10⁻⁷
	Pd 109	S	6×10⁻⁷	3×10⁻⁶	2×10⁻⁸	9×10⁻⁸
		I	4×10⁻⁷	2×10⁻⁶	1×10⁻⁸	7×10⁻⁸
Phosphorus (15)	P 32	S	7×10⁻⁸	5×10⁻⁶	2×10⁻⁹	2×10⁻⁷
		I	8×10⁻⁸	7×10⁻⁶	3×10⁻⁹	2×10⁻⁷
Platinum (78)	Pt 191	S	8×10⁻⁷	4×10⁻⁶	3×10⁻⁸	1×10⁻⁷
		I	6×10⁻⁷	3×10⁻⁶	2×10⁻⁸	1×10⁻⁷
	Pt 193m	S	7×10⁻⁶	3×10⁻⁵	2×10⁻⁷	1×10⁻⁶
		I	5×10⁻⁶	3×10⁻⁵	2×10⁻⁷	1×10⁻⁶
	Pt 197m	S	6×10⁻⁶	3×10⁻⁵	2×10⁻⁷	1×10⁻⁶
		I	5×10⁻⁶	3×10⁻⁵	2×10⁻⁷	9×10⁻⁷
	Pt 197	S	8×10⁻⁷	4×10⁻⁶	3×10⁻⁸	1×10⁻⁷
		I	6×10⁻⁷	3×10⁻⁶	2×10⁻⁸	1×10⁻⁷
Plutonium (94)	Pu 238	S	2×10⁻¹¹	1×10⁻⁴	7×10⁻¹⁴	5×10⁻⁷
		I	3×10⁻¹¹	6×10⁻⁴	1×10⁻¹³	2×10⁻⁶
	Pu 239	S	2×10⁻¹¹	1×10⁻⁴	6×10⁻¹⁴	5×10⁻⁷
		I	4×10⁻¹¹	8×10⁻⁴	1×10⁻¹³	3×10⁻⁶
	Pu 240	S	2×10⁻¹¹	1×10⁻⁴	6×10⁻¹⁴	5×10⁻⁷
		I	4×10⁻¹¹	8×10⁻⁴	1×10⁻¹³	3×10⁻⁶
	Pu 241	S	9×10⁻¹³	7×10⁻⁶	3×10⁻¹⁵	2×10⁻⁸
		I	4×10⁻¹²	4×10⁻⁵	1×10⁻⁹	1×10⁻⁷
	Pu 242	S	2×10⁻¹¹	1×10⁻⁴	6×10⁻¹⁴	5×10⁻⁷
		I	4×10⁻¹¹	9×10⁻⁴	1×10⁻¹³	3×10⁻⁶
Polonium (84)	Po 210	S	5×10⁻¹⁰	2×10⁻⁵	2×10⁻¹¹	7×10⁻⁷
		I	2×10⁻¹⁰	9×10⁻⁵	7×10⁻¹²	3×10⁻⁶
Potassium (19)	K42	S	2×10⁻⁶	9×10⁻⁶	7×10⁻⁸	3×10⁻⁷
		I	1×10⁻⁶	6×10⁻⁶	4×10⁻⁸	2×10⁻⁷
Praseodymium (59)	Pr 142	S	2×10⁻⁷	9×10⁻⁶	7×10⁻⁹	3×10⁻⁷
		I	2×10⁻⁷	9×10⁻⁶	5×10⁻⁹	3×10⁻⁷
	Pr 143	S	3×10⁻⁷	1×10⁻⁵	1×10⁻⁸	5×10⁻⁷
		I	2×10⁻⁷	1×10⁻⁵	6×10⁻⁹	5×10⁻⁷
Promethium (61)	Pm 147	S	6×10⁻⁶	6×10⁻⁵	2×10⁻⁸	2×10⁻⁶
		I	1×10⁻⁷	6×10⁻⁵	3×10⁻⁹	2×10⁻⁶
	Pm 149	S	3×10⁻⁷	1×10⁻⁵	1×10⁻⁸	4×10⁻⁷
		I	2×10⁻⁷	1×10⁻⁵	8×10⁻⁹	4×10⁻⁷
Protoactinium (91)	Pa 230	S	2×10⁻⁸	7×10⁻⁵	6×10⁻¹⁰	2×10⁻⁶
		I	8×10⁻⁸	7×10⁻⁵	3×10⁻¹⁰	2×10⁻⁶
	Pa 231	S	1×10⁻¹³	3×10⁻⁴	4×10⁻¹⁵	9×10⁻⁷
		I	1×10⁻¹³	8×10⁻⁴	4×10⁻¹⁵	2×10⁻⁶
	Pa 233	S	6×10⁻⁷	4×10⁻⁵	2×10⁻⁸	1×10⁻⁶
		I	2×10⁻⁷	3×10⁻⁵	6×10⁻⁹	1×10⁻⁶
Radium (88)	Ra 223	S	2×10⁻⁸	2×10⁻⁶	6×10⁻¹⁰	7×10⁻⁸
		I	2×10⁻¹⁰	1×10⁻⁶	8×10⁻¹²	4×10⁻⁸
	Ra 224	S	5×10⁻⁸	7×10⁻⁶	2×10⁻⁹	2×10⁻⁷
		I	7×10⁻¹⁰	2×10⁻⁶	2×10⁻¹¹	8×10⁻⁸
	Ra 226	S	3×10⁻¹⁰	4×10⁻⁷	1×10⁻¹²	1×10⁻⁸
		I	5×10⁻¹¹	9×10⁻⁷	2×10⁻¹²	3×10⁻⁸
	Ra 228	S	7×10⁻¹⁰	8×10⁻⁷	2×10⁻¹²	3×10⁻⁸
		I	4×10⁻¹⁰	2×10⁻⁶	1×10⁻¹²	3×10⁻⁸
Radon (86)	Rn 220	S	3×10⁻⁷	.....	1×10⁻⁸	.....
	Rn 222	S	1×10⁻⁷	.....	3×10⁻⁹	.....
Rhenium (75)	Re 183	S	3×10⁻⁶	2×10⁻⁵	9×10⁻⁸	6×10⁻⁷
		I	2×10⁻⁶	8×10⁻⁵	5×10⁻⁸	3×10⁻⁶
	Re 186	S	6×10⁻⁷	3×10⁻⁵	2×10⁻⁸	9×10⁻⁷
		I	2×10⁻⁷	1×10⁻⁵	6×10⁻⁹	5×10⁻⁷
	Re 187	S	9×10⁻⁶	7×10⁻⁵	3×10⁻⁷	2×10⁻⁶
		I	5×10⁻⁶	4×10⁻⁵	2×10⁻⁷	2×10⁻⁶
	Re 188	S	4×10⁻⁷	2×10⁻⁵	1×10⁻⁸	6×10⁻⁷
		I	2×10⁻⁷	9×10⁻⁶	6×10⁻⁹	3×10⁻⁷
Rhodium (45)	Rh 103m	I	8×10⁻⁶	4×10⁻⁵	3×10⁻⁸	1×10⁻⁶
	Rh 105	I	6×10⁻⁶	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
Rubidium (37)	Rb 86	S	8×10⁻⁷	4×10⁻⁵	3×10⁻⁸	1×10⁻⁶
		I	5×10⁻⁷	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
	Rb 87	S	3×10⁻⁷	2×10⁻⁵	1×10⁻⁸	7×10⁻⁷
		I	7×10⁻⁷	7×10⁻⁶	2×10⁻⁸	2×10⁻⁷
Ruthenium (44)	Ru 97	S	5×10⁻⁷	3×10⁻⁵	2×10⁻⁸	1×10⁻⁶
		I	7×10⁻⁷	5×10⁻⁵	2×10⁻⁸	2×10⁻⁶
	Ru 103	S	2×10⁻⁶	1×10⁻⁵	8×10⁻⁸	4×10⁻⁷
		I	2×10⁻⁶	1×10⁻⁵	6×10⁻⁸	3×10⁻⁷
	Ru 105	S	5×10⁻⁷	2×10⁻⁵	2×10⁻⁸	8×10⁻⁷
		I	4×10⁻⁷	2×10⁻⁵	1×10⁻⁸	8×10⁻⁷
	Ru 106	S	7×10⁻⁸	3×10⁻⁶	3×10⁻⁹	1×10⁻⁷
		I	5×10⁻⁸	3×10⁻⁶	2×10⁻⁹	1×10⁻⁷
Samarium (62)	Sm 147	S	8×10⁻⁶	4×10⁻⁵	3×10⁻⁸	1×10⁻⁶
		I	7×10⁻¹¹	2×10⁻⁵	2×10⁻¹²	7×10⁻⁷
	Sm 151	S	3×10⁻⁶	2×10⁻⁵	9×10⁻⁸	6×10⁻⁷
		I	6×10⁻⁶	2×10⁻⁵	2×10⁻⁷	6×10⁻⁷
	Sm 153	S	1×10⁻⁶	6×10⁻⁶	4×10⁻⁸	2×10⁻⁷
		I	1×10⁻⁶	6×10⁻⁶	4×10⁻⁸	2×10⁻⁷
Scandium (21)	Sc 46	S	4×10⁻⁷	2×10⁻⁵	1×10⁻⁸	6×10⁻⁷
		I	2×10⁻⁷	2×10⁻⁵	8×10⁻⁹	6×10⁻⁷
	Sc 47	S	2×10⁻⁶	1×10⁻⁵	6×10⁻⁸	4×10⁻⁷
		I	2×10⁻⁶	1×10⁻⁵	6×10⁻⁸	4×10⁻⁷
	Sc 48	S	1×10⁻⁶	6×10⁻⁶	4×10⁻⁸	2×10⁻⁷
		I	1×10⁻⁶	6×10⁻⁶	4×10⁻⁸	2×10⁻⁷
Selenium (34)	Se 75	S	2×10⁻⁶	9×10⁻⁶	6×10⁻⁸	3×10⁻⁷
		I	1×10⁻⁶	6×10⁻⁶	4×10⁻⁸	2×10⁻⁷

See footnotes at end of table.

APPENDIX B—Continued

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—continued

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-6}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	2×10^{-6}	1×10^{-4}
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	7×10^{-4}
		I	3×10^{-6}	2×10^{-2}	1×10^{-7}	7×10^{-4}
	Sr 85	S	2×10^{-7}	3×10^{-4}	8×10^{-9}	1×10^{-5}
		I	1×10^{-7}	5×10^{-4}	6×10^{-9}	2×10^{-5}
	Sr 89	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	1×10^{-5}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	3×10^{-10}	4×10^{-6}	1×10^{-11}	1×10^{-7}
		I	8×10^{-9}	1×10^{-4}	2×10^{-10}	4×10^{-6}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	8×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	5×10^{-7}	8×10^{-4}	9×10^{-9}	3×10^{-5}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-4}	1×10^{-9}	4×10^{-6}
		I	2×10^{-8}	1×10^{-4}	7×10^{-10}	4×10^{-6}
Technetium (43)	Tc 96m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
		I	5×10^{-6}	2×10^{-2}	1×10^{-7}	1×10^{-3}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97m	S	2×10^{-6}	1×10^{-3}	8×10^{-8}	4×10^{-5}
		I	2×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
	Tc 99m	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
	Tc 99	S	1×10^{-6}	1×10^{-3}	7×10^{-9}	4×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	2×10^{-5}
Tellurium (52)	Te 125m	S	4×10^{-7}	8×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
	Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
		I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	4×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	5×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	9×10^{-7}	8×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Thorium (90)	Th 228	S	9×10^{-9}	2×10^{-4}	3×10^{-10}	7×10^{-6}
		I	6×10^{-9}	4×10^{-4}	2×10^{-10}	1×10^{-5}
	Th 230	S	2×10^{-9}	5×10^{-5}	8×10^{-11}	2×10^{-6}
		I	10^{-11}	9×10^{-5}	3×10^{-4}	3×10^{-6}
Thorium (90)	Th 232	S	3×10^{-11}	8×10^{-5}	10^{-11}	2×10^{-6}
		I	3×10^{-11}	10^{-4}	10^{-11}	4×10^{-6}
	Th natural	S	3×10^{-11}	3×10^{-4}	10^{-11}	10^{-5}
		I	3×10^{-11}	3×10^{-4}	10^{-11}	10^{-5}
	Th 234	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	10^{-8}	2×10^{-4}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm 171	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	6×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
	Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	1×10^{-6}	1×10^{-2}	4×10^{-8}	4×10^{-4}
	W 185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	W 187	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U 230	S	3×10^{-11}	1×10^{-4}	1×10^{-10}	5×10^{-6}
		I	1×10^{-10}	1×10^{-4}	4×10^{-10}	5×10^{-6}
	U 232	S	1×10^{-10}	8×10^{-4}	3×10^{-10}	3×10^{-5}
		I	3×10^{-10}	8×10^{-4}	9×10^{-10}	3×10^{-5}
	U 233	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-11}	3×10^{-5}
	U 234	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-11}	3×10^{-5}
	U 235	S	6×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	8×10^{-4}	4×10^{-11}	3×10^{-5}
	U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	4×10^{-11}	3×10^{-5}
	U 238	S	7×10^{-11}	1×10^{-3}	3×10^{-11}	4×10^{-5}
		I	1×10^{-10}	1×10^{-3}	3×10^{-11}	4×10^{-5}
	U-natural	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	4×10^{-11}	3×10^{-5}
Vanadium (23)	V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe 131m	Sub	2×10^{-6}	.....	4×10^{-8}	.....
	Xe 133	Sub	1×10^{-6}	.....	3×10^{-8}	.....
	Xe 135	Sub	1×10^{-6}	.....	1×10^{-8}	.....
Ytterbium (70)	Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	3×10^{-3}	2×10^{-9}	1×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	8×10^{-7}	2×10^{-3}	3×10^{-8}	6×10^{-5}
	Zn 69	S	1×10^{-6}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	9×10^{-6}	5×10^{-3}	3×10^{-7}	2×10^{-4}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	6×10^{-5}
	Zr 97	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	2×10^{-4}
		I	9×10^{-8}	1×10^{-3}	3×10^{-9}	2×10^{-4}

[1] Soluble (S); Insoluble (I).

[2] "Sub" means that values given are for submersion in an infinite cloud of gaseous material.

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows. Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable MPC's, are MPC_A, and MPC_B, and MPC_C respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A}+\frac{C_B}{MPC_B}+\frac{C_C}{MPC_C}\leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix B shall be:

a. For purposes of Table I, Col 1—1×10^{-10}

b. For purposes of Table I, Col 2—3×10^{-7}

c. For purposes of Table II, Col 1—4×10^{-10}

d. For purposes of Table II, Col 2—1×10^{-4}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "B" for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "B" for any radionuclide which is not known to be absent from the mixture; or

Element (atomic number) and isotope	Table I		Table II	
	Column 1	Column 2	Column 1	Column 2
	Air (μc/ml)	Water (μc/ml)	Air (μc/ml)	Water (μc/ml)
If it is known that Sr 90, I 129, Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, and Th-nat are not present	..	9×10^{-4}	..	3×10^{-2}
If it is known that Sr 90, I 129, Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, and Th-nat are not present	..	6×10^{-4}	..	2×10^{-2}
If it is known that Sr 90, Pb 210, Ra 226 and Ra 228 are not present	..	2×10^{-4}	..	6×10^{-3}
If it is known that Ra 228 and Ra 228 are not present	..	3×10^{-4}	..	1×10^{-2}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241 and Bk 249 are not present	3×10^{-4}	..	1×10^{-2}	..
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-3}	..	1×10^{-2}	..
If it is known that alpha-emitters and Ac 227 are not present	8×10^{-3}	..	1×10^{-2}	..
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, and Cf 249 are not present	3×10^{-2}	..	1×10^{-2}	..
If Pa 231, Pu 239, Pu 240, Pu 242 and Cf 249 are not present	2×10^{-2}	..	7×10^{-2}	..

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Table I, Col. 1—1×10^{-10} μc/ml gross alpha activity; or 2.8×10^{-11} μc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1—3×10^{-9} μc/ml gross alpha activity; or 8×10^{-10} μc/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

[Amended]

CHANGE: Paragraph 3, Appendix "B" revised to read as set forth above, at 26 F.R. 11046, Nov. 25, 1961

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_a) to the concentration limit for that radionuclide specified in Table II of Appendix "B" (MPC_a) does not exceed 1/10, i.e. $\frac{C_a}{MPC_a} \leq \frac{1}{10}$, and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4 (i.e.,

$$\frac{C_a}{MPC_a}+\frac{C_b}{MPC_b}+\ldots\ldots\leq\frac{1}{4}).$$

[Added]

SOURCE: Paragraph 4, Appendix "B" appears at 25 F.R. 13053, Dec. 30, 1960; Paragraph 5, Appendix "B" appears at 26 F.R. 11046, Nov. 25, 1961.

APPENDIX C

Material	Microcuries	Material	Microcuries	Material	Microcuries
Ag^{110m}	1	I^{131}	10	Sr^{89}	1
Ar^{41}	10	K^{42}	10	Sm^{151}	10
As^{76}, As^{77}	10	La^{140}	10	Sn^{113}	10
Au^{198}	10	Mn^{52}	1	Sr^{89}	1
Au^{199}	10	Mn^{54}	10	$Sr^{90}+Y^{90}$	0.1
$Ba^{131}+La^{131}$	1	Mo^{99}	10	Ta^{182}	10
Be^{7}	20	Na^{24}	10	Tb^{160}	1
Cl^{38}	50	Nb^{93m}	10	Tc^{96}	1
Ca^{45}	10	Nb^{95}	10	Te^{127}	10
$Cd^{109}+Ag^{109m}$	10	Nb^{97}	1	Te^{129}	1
$Ce^{141}+Pr^{144}$	1	Nd^{147}	1	Th (natural)	50
Cl^{38}	1	Pd^{109}	10	Tl^{200}	20
Co^{58}	1	$Pd^{109}+Rh^{109}$	50	Tritium. See III	2*0
Co^{60}	1	P^{32}	10	U (natural)	50
Cr^{51}	50	Pm^{147}	10	V^{48}	1
$Cs^{137}+Ba^{137}$	1	Pr^{142}	0.1	W^{187}	50
Cu^{64}	50	Pt^{191}	10	Y^{90}	1
Eu^{152}	1	Pu^{239}	1	Yb^{175}	10
F^{18}	50	Ra^{226}	1	Zn^{65}	1
Fe^{55}	50	Re^{183}	0.1	Zr^{95}	1
Fe^{59}	1	Rh^{103m}	10	Unidentified radioactive materials or any of the above in unknown mixtures	0.1
Ga^{72}	10	Rh^{105}	10		
Ge^{71}	50	$Rn^{222}+Rb^{218}$	1		
H^3(HTO or H_2O)	250	Ru^{103}	50		
I^{126}	10	Sb^{124}	1		
In^{113}	1	Sb^{125}	1		

NOTE: For purposes of §§ 20.203 and 20.304, where there is involved a combination of isotopes in known amounts the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity").

EXAMPLE: For purposes of § 20.304, if a particular batch contains 2,000 μc of Au^{198} and 25,000 μc of C^{14}, it may also include not more than 3,000 μc of I^{131}. This limit was determined as follows:

$$\frac{2{,}000\ \mu c\ Au^{198}}{50{,}000\ \mu c}+\frac{25{,}000\ \mu c\ C^{14}}{50{,}000\ \mu c}+\frac{3{,}000\ \mu c\ I^{131}}{10{,}000\ \mu c}=1.$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1,000 as provided in § 20.304.

APPENDIX D

UNITED STATES ATOMIC ENERGY COMMISSION

COMPLIANCE OFFICES

Region	Address	Telephone
I		
Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	Region I, Division of Compliance, USAEC 376 Hudson Street New York 14, N.Y.	YUkon 9-1000, Ext 281.
II		
Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Panama Canal Zone, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia.	Region II, Division of Compliance, USAEC 50 Seventh Street NE. Atlanta 23, Ga.	873-6146.
III		
Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.	Region III, Division of Compliance, USAEC Oakbrook Professional Building, Oak Brook, Ill.	654-1020 (nights and holidays—Clearwater 7-7711, Ext. 341).
IV		
Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming.	Region IV, Division of Compliance, USAEC P.O. Box 18206 Denver 15, Colo.	237-5094.
V		
Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington and U.S. territories and possessions in the Pacific.	Region V, Division of Compliance, USAEC 2111 Bancroft Way Berkeley 4, Calif.	THornwall 1-2420

NOTE: The record keeping and reporting requirements contained in this part have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

[Amended]

CHANGE: Appendix "D" amended to read as set forth above, at 27 F.R. 5905, June 22, 1962 and 27 F.R. 10939, Nov. 7, 1962.

PART 30—LICENSING OF BYPRODUCT MATERIAL

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30.73 Schedule C
30.75 Schedule E

AUTHORITY: §§ 30.1 to 30.72 issued under sec. 161, 68 Stat. 948; 42 U. S. C. 2201. Interpret or apply secs. 81, 82, 182, 183, 68 Stat. 935, 953, 954, 42 U. S. C. 2111, 2112, 2232, 2233. For the purposes of sec. 223, 68 Stat. 958; 42 U. S. C. 2273, §§ 30.21 (b) and 30.32 (c) issued under sec. 161b, 68 Stat. 948; 42 U. S. C. 2201 (b) and §§ 30.41, 30.42 and 30.43 issued under sec. 161p, 68 Stat. 950; 42 U. S. C. 2201 (p).

SOURCE: §§ 30.1 to 30.72 appear at 21 F. R. 213, Jan. 11, 1956, except as otherwise noted

GENERAL PROVISIONS

PART 30—LICENSING OF BYPRODUCT MATERIAL

§ 30.1 *Purpose.* The regulations in this part are promulgated by the Atomic Energy Commission, pursuant to the Atomic Energy Act of 1954 (68 Stat. 919), to provide for the licensing of byproduct material.

§ 30.2 *Scope.* Except as provided in §§ 30.6 to 30.8, the regulations in this part apply to all persons in the United States.

§ 30.3 *License requirements.* No person subject to the regulations in this part shall manufacture, produce, transfer, receive, acquire, own, possess, use, import or export byproduct material except as authorized in a specific or general license issued pursuant to the regulations in this part.

§ 30.4 *Definitions.* As used in this part:

(a) "Act" means the Atomic Energy Act of 1954, including any amendments thereto;

(b) "Byproduct material" means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

(c) "Commission" means the Atomic Energy Commission and its duly authorized representatives;

(d) "Curie" means that amount of radioactive material which disintegrates at the rate of 37 billion atoms per second;

(e) "Human use" means the internal or external administration of byproduct material, or the radiation therefrom, to human beings;

(f) "License," except where otherwise specified means a license issued pursuant to the regulations in this part;

(g) "Microcurie" means that amount of radioactive material which disintegrates at the rate of 37 thousand atoms per second;

(h) "Person" means (1) any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission, any State or any political subdivision of, or any political entity within a State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and (2) any legal successor, representative, agent, or agency of the foregoing;

(i) "Physician" means an individual licensed by a state or territory of the United States, the District of Columbia or the Commonwealth of Puerto Rico to dispense drugs in the practice of medicine;

(j) "Production facility" means production facility as defined in the regulations contained in Part 50 of this chapter;

(k) "Research and development" means (1) theoretical analysis, exploration or experimentation; or (2) the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials and processes. "Research and development" as used in this part does not include the internal or external administration of byproduct material, or the radiation therefrom, to human beings;

(l) "Sealed source" means any byproduct material that is encased in a capsule designed to prevent leakage or escape of the byproduct material.

[Amended]

CHANGE: § 30.4(l) amended by substituting "a capsule designed to prevent leakage or escape of the byproduct material" for "and is to be used in, a container in a manner intended to prevent leakage of the byproduct material" at 25 F.R. 12199, Nov. 29, 1960.

(m) "Source material" means source material as defined in the regulations contained in Part 40 of this chapter;

(n) "Special nuclear material" means special nuclear material as defined in the regulations contained in Part 70 of this chapter;

(o) "United States," when used in a geographical sense, includes all territories and possessions of the United States, the Canal Zone and Puerto Rico.

(p) "Utilization facility" means a utilization facility as defined in the regulations contained in Part 50 of this chapter;

(q) Other terms defined in section 11 of the act shall have the same meaning when used in the regulations in this part.

(r) "Radiographer" means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of the regulations of this part and the conditions of the license.

(s) "Radiographer's assistant" means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources

or related handling tools, or survey instruments in radiography.

(t) "Radiography" means the examination of the structure of materials by nondestructive methods utilizing sealed sources of byproduct materials.

(u) "Agreement State" as designated in Part 150 of this chapter means any State with which the Commission has entered into an effective agreement under subsection 274.(b) of the Atomic Energy Act of 1954, as amended. "Non-agreement State" means any other State.

[Added]

SOURCE: § 30.4 (r), (s) and (t) appear at 25 F.R. 12169, Nov. 29, 1960. (t) appears at 27 F.R. 1350, Feb. 14, 1962, and "(t)" corrected as "(u)" at 27 F.R. 2884, Mar. 29, 1962.

§ 30.5 *Interpretations.* Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

EXEMPTIONS

§ 30.6 *Persons operating Commission-owned facilities.* Any person is exempt from the requirements for a license set forth in section 81 or 82 of the act and from the regulations in this part to the extent that such person operates Commission-owned plants and laboratories on behalf of the Commission. In any such case, such person's obligations with respect to the byproduct material are covered by the applicable contract between such person and the Commission.

§ 30.7 *Carriers.* Common and contract carriers and the United States Post Office Department are exempt from the regulations in this part and the requirements for a license set forth in section 81 of the act to the extent that they transport byproduct material in the regular course of their business as carriers.

§ 30.8 *Other exemptions.* The Commission may upon the application of any interested person, or upon its own initiative, exempt certain classes or quantities of byproduct material or kinds of uses or users from the requirements for a license set forth in section 81 of the act and in the regulations in this part, when it makes a finding that the exemption of such classes or quantities of such material or such kinds of uses or users will not constitute an unreasonable risk to the common defense and security and to the health and safety of the public.

§ 30.9 *Exempt concentrations.* (a) Except as provided in § 30.32(f), any person is exempt from the requirements for a license set forth in section 81 of the Act and from the regulations in this part to the extent that such person receives, possesses, uses, transfers, owns or acquires products or materials containing byproduct material in concentrations not in excess of those listed in § 30.73.

(b) This section shall not be deemed to authorize the import of byproduct material or products containing byproduct material.

[Added]

SOURCE: § 30.9 appears at 25 F.R. 7975, Aug. 17, 1960.

§ 30.10 *Certain luminous timepieces.* (a) Except for persons who apply tritium to luminous timepieces or hands or dials and persons who import for sale or distribution luminous timepieces or hands or dials containing tritium, any person is exempt from the requirements for a license set forth in section 81 of the Act and from the regulations in Parts 20 and 30 of this chapter to the extent that such person receives, possesses, uses, transfers, exports, owns or acquires luminous timepieces or hands or dials containing tritium.

(b) Any person who desires to apply tritium to luminous timepieces or hands or dials for sale or distribution, or desires to import for sale or distribution luminous timepieces or hands or dials containing tritium, should apply for a specific license, pursuant to § 30.24(f), which license states that the luminous timepieces or hands or dials may be distributed by the licensee to persons exempt from the regulations pursuant to paragraph (a) of this section.

[Added]

SOURCE: § 30.10 appears at 25 F.R. 12730, Dec. 13, 1960.

§ 30.12 *Lock illuminators installed in automobile locks.* Any person is exempt from the requirements for a license set forth in section 81 of the Act and from the regulations in Part 20 of this chapter and this part to the extent that he receives, possesses, uses, transfers, exports, owns or acquires lock illuminators each containing not more than 15 millicuries of tritium installed in an automobile lock. The manufacture, installation into automobile locks, or importation for sale or distribution of lock illuminators whether or not installed in automobile locks, is not included in this exemption, but may be authorized by a specific license under the provisions of this part.

[Added]

SOURCE: § 30.12 appears at 26 F.R. 10473, Nov. 7, 1961.

GENERAL LICENSES; APPLICATIONS FOR LICENSES

§ 30.20 *Types of licenses.* (a) Licenses for byproduct material are of two types: general and specific. The general licenses provided in § 30.21 are effective without the filing of applications with the Commission or the issuance of licensing documents to particular persons. Specific licenses are issued to named persons upon applications filed pursuant to the regulations in this part.

§ 30.21 *General licenses.* (a) A general license is hereby issued:

(1) To transfer, receive, acquire, own, possess and use byproduct material incorporated in a device or equipment which is listed in § 30.71 and has been manufactured pursuant to a specific license issued by the Commission.

(2) To transfer, receive, acquire, own, possess, use and import the quantities of byproduct materials listed in § 30.72, provided that no person shall at any one time possess or use, pursuant to the general licensing provisions of this paragraph, more than a total of ten such scheduled quantities.

(b) The general licenses provided in this section are subject to the provisions of §§ 30.32 to 30.72, inclusive of the regulations in this part and are subject to the regulations contained in Part 20 of this chapter.[1] In addition, persons who transfer, receive, acquire, own, possess, use or import scheduled items and quantities of byproduct material pursuant to the general licenses provided in paragraph (a) of this section.

(1) Shall not effect an increase in the radioactivity of said scheduled items or quantities by adding other radioactive material thereto, by combining byproduct material from two or more such items or quantities, or by altering them in any other manner so as to increase thereby the rate of radiation therefrom;

(2) Shall not administer externally or internally, or direct the administration of, said scheduled items or quantities or any part thereof to a human being for any purpose, including, but not limited to, diagnostic, therapeutic, and research purposes.

(3) Shall not add, or direct the addition of, said scheduled items or quantities or any part thereof to any food, beverage, cosmetic, drug, or other product designed for ingestion or inhalation by, or application to, a human being;

(4) Shall not include said scheduled items or quantities or any part thereof in any device, instrument, apparatus (including component parts and accessories thereto) intended for use in diagnosis, treatment or prevention of disease in human beings or animals or otherwise intended to affect the structure or any function of the body of human beings or animals.[1]

(c)(1) Subject to the provisions of subparagraphs (2) to (6) of this paragraph (c), a general license is hereby issued to own, receive, acquire, possess and use byproduct material when contained in devices designed and manufactured for the purpose of detecting measuring gauging or controlling thickness, density, level, interface location radiation leakage, or qualitative or quantitative chemical composition, or for producing light or an ionized atmosphere.

(2) The general license contained in subparagraph (1) of this paragraph (c) applies only to devices which have been:

(i) Manufactured in accordance with the specifications contained in a specific license issued by the Commission to the manufacturer of the device pursuant to § 30.24(f), or, in accordance with the specifications contained in a specific license issued to the manufacturer by an agreement State; and

(ii) Installed on the premises of the general licensee by a person authorized to install such devices under a specific license issued to the installer by the

[1] Attention is directed particularly to the provisions of the regulations in Part 20 of this chapter which relate to the labelling of containers

Commission pursuant to this part or by an agreement State, provided that the specific license referred to in subdivision (i) of this subparagraph (2) contains provisions authorizing the transfer of such devices to, and the installation of such devices in the premises of, general licensees.

(3) The general license contained in subparagraph (1) of this paragraph (c) applies only to devices which (i) are labeled in accordance with the provisions of the specific license which authorizes the distribution of the device to general licensees, and (ii) bear a label containing the following or a substantially similar statement which contains the information called for in the following statement:

This device, generally licensed pursuant to § 30.21(c) of 10 CFR, Part 30, has been manufactured and distributed pursuant to license No. ..... issued by .....
(Insert either "Atomic Energy Commission" or name of agreement State, whichever is applicable)

.....
(Name of supplier)

(4) Persons who own, receive, acquire, possess or use a device pursuant to the general license contained in subparagraph (1) of this paragraph (c):

(i) Shall not transfer, abandon or dispose of the device, except by transfer to a person authorized by a specific license from the Commission or an agreement State to receive such device;

(ii) Shall assure that all labels affixed to the device at the time of receipt and bearing the statement, "Removal of this label is prohibited by regulations of the Atomic Energy Commission", are maintained thereon and shall comply with all instructions contained in such labels;

(iii) Shall have the device tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at no longer than six-month intervals; provided that devices containing only krypton need not be tested for leakage, and devices containing only tritium need not be tested for any purpose;

(iv) Shall have the tests required by subdivision (iii) of this subparagraph and all other services involving the radioactive material, its shielding and containment performed by the supplier or other person holding a specific license from the Commission or an agreement State to manufacture, install or service such devices;

(v) Shall maintain records of all tests performed on the devices as required under this section, including the dates and results of the tests and the names of the persons conducting the tests;

(vi) Upon the occurrence of a failure of or damage to, or any indication of a possible failure of or damage to, the shielding or containment of the radioactive material or the on-off mechanism or indicator, shall immediately suspend operation of the device until it has been repaired by the supplier or other person holding a specific license from the Commission or an agreement State to manufacture, install or service such devices, or disposed of by transfer to a person authorized to receive the byproduct material contained in the device; and

(vii) Shall be exempt from the requirements of Part 20 of this chapter, except that such persons shall comply with the provisions of §§ 20.402 and 20.403 of this chapter.

(5) The general license provided in subparagraph (1) of this paragraph (c) is subject to the provisions of §§ 30.32 to 30.72, inclusive; *Provided*, That persons who possess byproduct material pursuant to this general license shall not export such byproduct material without a specific license from the Commission authorizing such export.

(6) Any person who holds a specific license issued by an agreement State authorizing the holder to manufacture, install or service a device described in subparagraph (1) of this paragraph (c) within such agreement State is hereby granted a general license to install and service such device in any nonagreement State; *Provided*, That:

(i) Such person shall file a report with the Director, Division of Licensing and Regulation, Atomic Energy Commission, Washington 25, D.C., within 30 days after the end of each calendar quarter in which any device is transferred or installed. Each such report shall identify each general licensee by name and address, the type of device transferred, and the quantity and type of byproduct material contained in the device.

(ii) The device has been manufactured, labelled, installed, and serviced in accordance with applicable provisions of the specific license issued to such person by the agreement State;

(iii) Such person assures that any labels required to be affixed to the device under regulations of the agreement State which licensed manufacture of the device bear a statement that "Removal of this label is prohibited by the regulations of the Atomic Energy Commission".

(iv) Shall furnish to each general licensee to whom he transfers such device or on whose premises he installs such device a copy of the general license contained in § 30.21(c).

[Amended]

SOURCE: Paragraph (c) of § 30.21 is amended as set forth above at 27 F.R. 1350, Feb. 14, 1962.

(d)(1) A general license is hereby issued to own, receive, acquire, possess and use tritium contained in luminous safety devices for use in aircraft, provided each device contains not more than four curies of tritium and that each device has been manufactured, assembled or imported in accordance with a license issued under the provisions of § 30.24.

(2) Persons who own, receive, acquire, possess or use luminous safety devices pursuant to the general license in subparagraph (1) of this paragraph are exempt from the requirements of Part 20 of this chapter, except that they shall comply with the provisions of §§ 20.402 and 20.403 of this chapter.

(3) This general license does not authorize the manufacture, assembly, repair or import of luminous safety devices containing tritium.

(4) This general license does not authorize the export of luminous safety devices containing tritium except in accordance with the provisions of § 30.33.

[Added]

SOURCE: § 30.21(d), appears at 27 F.R. 2394, Mar. 14, 1962.

§ 30.22 *Applications for specific licenses.* (a) Applications for specific licenses shall be filed on Form AEC 313, "Application for By-Product Material License", with the United States Atomic Energy Commission, 1717 H Street NW., Washington, D. C. Attention: Isotopes Division, and shall set forth the information called for by the form. Information contained in previous applications, statements or reports filed with the Commission may be incorporated by reference, provided that such references are clear and specific.

[Amended]

CHANGE: Paragraph (a) of § 30.22 amended by substituting "1717 H Street NW., Washington, D. C." for "Post Office Box E, Oak Ridge, Tennessee" at 23 F. R. 1122, Feb. 21, 1958.

(b) The Commission may at any time after the filing of the original application, and before the expiration of the license, require further statements in order to enable the Commission to determine whether the application should be granted or denied or whether a license should be modified or revoked.

(c) Each application shall be signed by the applicant or licensee or a person duly authorized to act for and on his behalf.

[Amended]

CHANGE: Paragraph (c) of § 30.22 amended by deleting words "under oath or affirmation" after words "signed" at 21 F. R. 7265, Sept. 25, 1956.

(d) An application for license filed pursuant to the regulations in this part will be considered also as an application for licenses authorizing other activities for which licenses are required by the act, provided that the application specifies the additional activities for which licenses are requested and complies with regulations of the Commission as to applications for such licenses.

§ 30.23 *General requirements for issuance of specific licenses.* An application for a specific license will be approved if:

(a) The application is for a purpose authorized by the act; and

(b) The applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life or property; and

(c) The applicant is qualified by training and experience to use the material for the purpose requested in such manner as to protect health and minimize danger to life or property; and

(d) The applicant satisfies any applicable special requirements contained in § 30.24

§ 30.24 *Special requirements for issuance of specific licenses.*—(a) *Human use in institutions.* An application by an institution for a specific license for human use will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant has appointed a medical isotopes committee of at least three members to evaluate all proposals for research, diagnosis, and therapeutic use of radioisotopes within that institution. Membership of the committee should include physicians expert in internal medicine, hematology, therapeutic radiology, and a person experienced in assay of radioisotopes and protection against ionizing radiations; and

(3) The applicant possesses adequate facilities for the clinical care of patients; and

(4) The physician designated on the application as the individual user has substantial experience in the proposed use, the handling and administration of radioisotopes and, where applicable, the clinical management of radioactive patients; and

(5) If the application is for a license to use unspecified quantities or multiple types of byproduct material, the applicant has previously received a reasonable number of licenses for a variety of byproduct materials for a variety of human uses.

(b) *Licensing of individual physicians for human use.* An application by an individual physician for a specific license for human use will be approved if the applicant:

(1) Satisfies the general requirements specified in § 30.23;

(2) The applicant has access to a hospital possessing adequate facilities to hospitalize and monitor the applicant's radioactive patients whenever it is advisable; and

(3) The applicant has extensive experience in the proposed use, the handling and administration of radioisotopes, and where applicable, the clinical management of radioactive patients. (The physician shall furnish suitable evidence of such experience with his application. A statement from the medical isotope committee in the institution where he acquired his experience, indicating its amount and nature, may be submitted as evidence of such experience.)

(c) *"Human use" of sealed sources.* An application for a specific license for use of a sealed source for human use will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant or, if the application is made by an institution, the individual user (i) has specialized training in the therapeutic use of the radioactive device considered (teletherapy unit, beta applicator, etc.) or has experience equivalent to such training; and (ii) is a physician.

(d) *Multiple quantities or types of byproduct material for use in research and development.* An application for a specific license for multiple quantities or types of byproduct material for use in research and development will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant has received a reasonable number of licenses for a variety of radioisotopes for a variety of research and development uses; and

(3) The applicant has established an isotope committee (composed of such persons as a radiological safety officer, a representative of the business office, and one or more persons trained or experienced in the safe use of radioactive materials) which will review and approve, in advance of purchase of radioisotopes, proposals for such uses; and

(4) The applicant has appointed a radiological safety officer who will advise on or be available for advice and assistance on radiological safety problems.

(e) *Multiple quantities or types of byproduct material for use in processing.* An application for a specific license for multiple quantities or types of byproduct material for use in processing for distribution to other authorized persons will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant has received a reasonable number of licenses for processing and distribution of a variety of radioisotopes; and

(3) The applicant has appointed a radiological safety officer who will advise on or be available for advice and assistance on radiological safety problems.

(f) *Distribution of devices to persons generally licensed under § 30.21(c).* An application for a specific license to distribute certain devices of the types enumerated in § 30.21(c) to persons generally licensed under § 30.21(c) will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant submits sufficient information relating to the design, manufacture, prototype testing, quality control procedures, labeling, proposed uses and potential hazards of the device to provide reasonable assurance that:

(i) The byproduct material contained in the device will not be lost;

(ii) That no person would receive a radiation exposure to a major portion of his body in excess of 0.5 rem in a year under ordinary circumstances of use;

(iii) The device can be safely operated by persons not having training in radiological protection; and

(iv) The byproduct material within the device would not be accessible to unauthorized persons.

(3) In describing the label or labels and contents thereon to be affixed to the device, the applicant should separately indicate those instructions and precautions which are necessary to assure safe operation of the device. Such instructions and precautions must be contained on labels bearing the statement, "Removal of this label prohibited by regulations of the Atomic Energy Commission."

[Added]

SOURCE: § 30.24(f) appears at 24 F.R. 1000, Feb. 12, 1959.

(g) *Use of sealed sources in radiography.* An application for a specific license for use of sealed sources in radiography will be approved if:

(1) The applicant satisfies the general requirements specified in § 30.23; and

(2) The applicant will have an adequate program for training radiographers and radiographers' assistants and submits to the Commission a schedule or description of such program which specifies the:

(i) Initial training;

(ii) Periodic training;

(iii) On-the-job training;

(iv) Means to be used by the licensee to determine the radiographer's knowledge and understanding of and ability to comply with Commission regulations and licensing requirements, and the operating and emergency procedures of the applicant;

(v) Means to be used by the licensee to determine the radiographer's assistant's knowledge and understanding of and ability to comply with the operating and emergency procedures of the applicant; and

(3) The applicant has established and submits to the Commission satisfactory written operating and emergency procedures as described in § 31.202 of this chapter; and

(4) The applicant will have an adequate internal inspection system, or other management control, to assure that Commission license provisions, Commission regulations, and the applicant's operating and emergency procedures are followed by radiographers and radiographers' assistants; and

(5) The applicant submits a description of its overall organizational structure pertaining to the radiography program, including specified delegations of authority and responsibility for operation of the program; and

(6) The applicant who desires to conduct his own leak tests has established adequate procedures to be followed in leak testing sealed sources, for possible leakage and contamination and submits to the Commission a description of such procedures including:

(i) Instrumentation to be used.

(ii) Method of performing test, e.g., points on equipment to be smeared and method of taking smear, and

(iii) Pertinent experience of the person who will perform the test.

[Added]

SOURCE: § 30.24(g) appears at 25 F.R. 12169, Nov. 29, 1960.

(h) *Licensing the transfer of products containing exempt concentrations of byproduct material.* (1) An application for a specific license to transfer possession or control of products or materials containing exempt concentrations of byproduct material which the transferor has introduced into the product or material will be approved if the applicant:

(i) Satisfies the general requirements specified in § 30.23;

(ii) Submits a description of the product or material into which the byproduct material will be introduced, intended use of the byproduct material and the product into which it is introduced, method of introduction, initial concentration of the byproduct material in the product or material, control methods to assure that no more than the specified concentration is introduced into the product or material, estimated time interval between introduction and transfer of the product or material, and estimated concentration of the radioisotope in the product or material at the time of transfer by the licensee; and

(iii) Provides reasonable assurance that the concentrations of the byproduct material at the time of transfer will not exceed the concentrations in § 30.73, that reconcentration of the byproduct material in concentrations exceeding those in § 30.73 is not likely, that the product or material is not likely to be inhaled or ingested, and that use of lower concentrations is not feasible.

(2) Each person licensed under this paragraph shall file an annual report with the Director, Division of Licensing and Regulation, describing the kinds and quantities of products transferred, the concentration of byproduct material contained and the quantity of byproduct material transferred during the reporting period. Each report shall be filed as of June 30 and shall be filed within 30 days thereafter.

[Added]

SOURCE: § 30.24(h) appears at 25 F.R. 7875, Aug. 17, 1960.

(i) *Certain luminous timepieces.* An application for a specific license to apply tritium contained in luminous compounds to timepieces or hands or dials, or to import timepieces or hands or dials containing tritium for use pursuant to § 30.10 will be approved if: (1) The applicant satisfies the general requirements specified in § 30.23 and (2) the applicant submits sufficient information relating to the chemical and physical composition and characteristics of the luminous compound(s), the method of application of each compound, quality control procedures and prototype testing of luminous dials, and

(i) The tritium is bound in the luminous compound in a non-water-soluble and non-labile form and the compound is bound to the dials or hands. The tritium will be considered to be properly bound to the dials and hands if there is no visible flaking or chipping and the total loss of tritium does not exceed 5 percent of the total tritium when prototype dials and hands are subjected to the following tests in the order specified below:

(a) Attachment of dials to a vibrating fixture and vibration at a rate of not less than 25 cycles per second and a vibration acceleration of not less than 2G for a period of not less than one hour and

(b) Attachment of the hub ends of the hands to a clamp and bending of hands over a one-inch diameter cylinder; and

(c) Total immersion of the dials and hands used in the tests described in (a) and (b) of this subdivision in 100 milliliters of water at room temperature for a period of 24 consecutive hours and analysis of the test water for its radioactive material content by liquid scintillation counting or other equally sensitive method.

(ii) Not more than a total of 25 millicuries of tritium will be applied per timepiece; and

(iii) Not more than a total of 5 millicuries of tritium will be applied per hand and not more than 15 millicuries will be applied per dial (bezels when used shall be considered as part of the dial).

[Added]

SOURCE: § 30.24(i) appears at 25 F.R. 12730, Dec. 13, 1960.

(j) *Luminous safety devices for use in aircraft.* (1) An application for a specific license to manufacture, assemble, repair or import luminous safety devices, for distribution to persons generally licensed under § 30.21(d), will be approved if:

(i) The applicant satisfies the general requirements specified in § 30.23;

(ii) The applicant submits sufficient information regarding each device pertinent to evaluation of the potential radiation exposure, including:

(a) Chemical and physical form and maximum quantity of tritium in each device;

(b) Details of construction and design;

(c) Details of the method of binding or containing the tritium;

(d) Procedures for and results of prototype testing to demonstrate that the tritium will not be released to the environment under the most severe conditions likely to be encountered in normal use;

(e) Any quality control procedures proposed as alternatives to those prescribed by subparagraph (2)(ii) of this paragraph;

(f) Any additional information, including experimental studies and tests, required by the Commission to facilitate a determination of the safety of the device.

(iii) Each device will contain no more than four curies of tritium.

(iv) The Commission determines that:

(a) The method of incorporation and binding of the tritium in the device is such that the tritium will not be released under the most severe conditions which are likely to be encountered in normal use and handling of the device.

(b) The tritium is incorporated or enclosed so as to preclude direct physical contact by any person with it;

(c) The device is so designed that it cannot easily be disassembled, and

(d) The device has been subjected to and has satisfactorily passed the prototype tests prescribed by subdivision (v) of this subparagraph (1).

(v) The applicant has conducted prototype tests on each of five prototype devices as follows:

(a) *Temperature-altitude test.* The tritium device shall be placed in a test chamber as it would be used in service. A temperature-altitude condition schedule shall be followed as outlined in the following steps:

Step 1. The internal temperature of the test chamber shall be reduced to −62° C. (−80° F.) and the device shall be maintained for at least 1 hour at this temperature at atmospheric pressure.

Step 2. The internal temperature of the test chamber shall be raised to −54° C. (−65° F.) and maintained until the temperature of the device has stabilized at −54° C. at atmospheric pressure.

Step 3. The atmospheric pressure of the chamber shall be reduced to 83 millimeters of mercury absolute pressure while the chamber temperature is maintained at −54° C.

Step 4. The internal temperature of the chamber shall be raised to −10° C. (+14° F.) and maintained until the temperature of the device has stabilized at −10° C., and the internal pressure of the chamber shall then be adjusted to atmospheric pressure. The test chamber door shall then be opened in order that frost will form on the device, and shall remain open until the frost has melted but not long enough to allow the moisture to evaporate. The door shall then be closed.

Step 5. The internal temperature of the chamber shall be raised to +85° C. (185° F.) at atmospheric pressure. The temperature of the device shall be stabilized at +85° C. and maintained for 2 hours. The device shall then be visually inspected to determine the extent of any deterioration.

Step 6. The chamber temperature shall be reduced to +71° C. (160° F.) at atmospheric pressure. The temperature of the device shall be stabilized at +71° C. for a period of 30 minutes.

Step 7. The chamber temperature shall be reduced to +55° C. (130° F.) at atmospheric pressure. The temperature of the device shall be stabilized at this temperature for a period of 4 hours.

Step 8. The internal temperature of the chamber shall be reduced to +30° C. (86° F.) and the pressure to 138 millimeters of mercury absolute pressure and stabilized. The device shall be maintained under these conditions for a period of 4 hours.

Step 9. The temperature of the test chamber shall be raised to +35° C. (95° F.) and the pressure reduced to 83 millimeters of mercury absolute pressure and stabilized. The device shall be maintained under these conditions for a period of 30 minutes.

Step 10. The internal pressure of the chamber shall be maintained at 83 millimeters of mercury absolute pressure and the temperature reduced to +20° C. (68° F.) and stabilized. The device shall be maintained under these conditions for a period of 4 hours.

(b) *Vibration tests.* This procedure applies to items of equipment (including vibration isolating assemblies) intended to be mounted directly on the structure of aircraft powered by reciprocating turbojet, or turbo-propeller engines or to be mounted directly on gas-turbine engines. The device shall be mounted on an apparatus dynamically similar to the most severe conditions likely to be encountered in normal use. At the end of the test period, the device shall be inspected thoroughly for possible damage. Vibration tests shall be conducted under both resonant and cycling conditions according to the following Vibration Test Schedule (Table I):

VIBRATION TEST SCHEDULE

TABLE I

[Times shown refer to one axis of vibration]

Type	Vibration at room temperature	Vibration at 160° F. (71° C.)	Vibration at −65° F. (−54° C.)
	Minutes	*Minutes*	*Minutes*
Resonance	60	15	15
Cycling	90	15	15

(1) *Determination of resonance frequency.* Individual resonance frequency surveys shall be conducted by applying vibration to each device along each of any set of three mutually perpendicular axes and varying the frequency of applied vibration slowly through a range of frequencies from 5 cycles per second to 500 cycles per second with the double amplitude of the vibration not exceeding that shown in Figure 1 for the related frequency.

(2) *Resonance tests.* The device shall be vibrated at the determined resonance frequency for each axis of vibration for the periods and temperature conditions shown in Table I and with the applied double amplitude specified in Figure 1 for that resonance frequency. When more than one resonant frequency is encountered with vibration applied along any one axis, the test period may be accomplished at the most severe resonance or the period may be divided among the resonant frequencies, whichever is considered most likely to produce failure. When resonant frequencies are not apparent within the specified frequency range, the specimen shall be vibrated for periods twice as long as those shown for resonance in Table I at a frequency of 55 cycles per second and an applied double amplitude of 0.060 inch.

(3) *Cycling.* Devices to be mounted only on vibration isolators shall be tested by applying vibration along each of three mutually perpendicular axes of the device with an applied double amplitude of 0.060 inch and the frequency cycling between 10 and 55 cycles per second in 1-minute cycles for the periods and temperature conditions shown in Table I. Devices to be installed in aircraft without vibration isolators shall be tested by applying vibration along each of three mutually perpendicular axes of the device with an applied double amplitude of 0.036 inch or an applied acceleration of 10g, whichever is the limiting value, and the frequency cycling between 10 and 500 cycles per second in 15-minute cycles for the periods and temperature conditions shown in Table I.

(c) *Accelerated weathering tests.* The device shall be subjected to 100 hours of accelerated weathering in a suitable weathering machine. Panels of Corex D [illegible] shall surround the arc to cut off the ultraviolet radiation below a wavelength of 2700 angstroms. The light of the carbon arcs shall fall directly on the face of the device. The temperature at the sample shall be maintained at 50° C. plus or minus 3° C. Temperature measurements shall be made with a black panel thermometer.

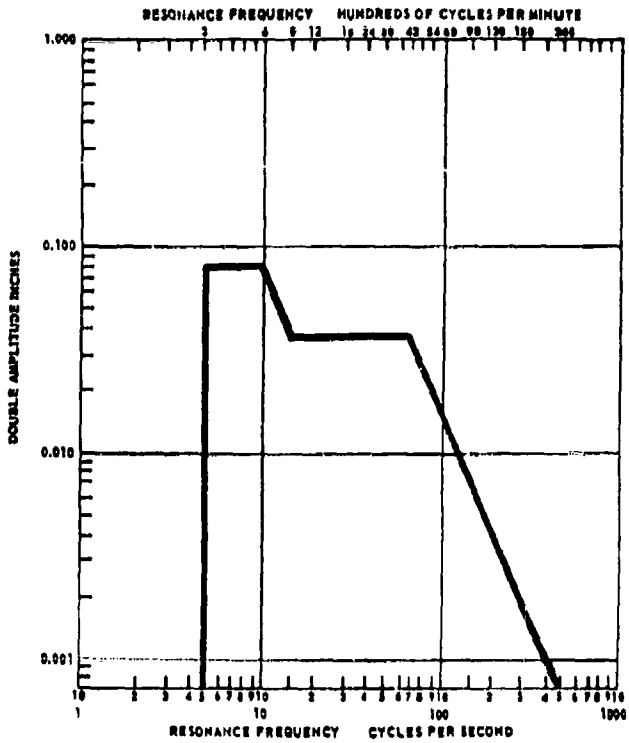

FIGURE 1—Amplitude of vibration at resonance frequency.

(d) *Shock test.* The device shall be dropped upon a concrete or iron surface in a 3-foot free gravitational fall, or shall be subjected to equivalent treatment in a test device simulating such a free fall. The drop test shall be repeated 100 times from random orientations.

(e) *Hermetic seal and waterproof test.* On completion of all other tests prescribed by this subdivision (v), the device shall be immersed in 30 inches of water for 24 hours and shall show no visible evidence of water entry. Absolute pressure of the air above the water shall then be reduced to 1 inch of mercury. Lowered pressure shall be maintained for 1 minute or until air bubbles cease to be given off by the water, whichever is the longer. Pressure shall then be increased to normal atmospheric pressure. Any evidence of bubbles emanating from within the device, or water entering the device, shall be considered leakage.

(f) *Observations.* After each of the tests prescribed by this subdivision (v), each device shall be examined for evidence of physical damage and for loss of tritium. Any evidence of damage to or failure of any device which could affect containment of the tritium shall be cause for rejection of the design if the damage or failure is attributable to a design defect. Loss of tritium from each tested device shall be measured by wiping with filter paper an area of at least 100 square centimeters on the outside surface of the device or by wiping the entire surface area if it is less than 100 square centimeters. The amount of tritium in the water used in the hermetic seal and waterproof test prescribed by test (e) of this subdivision shall also be measured. Measurements shall be made in an apparatus calibrated to measure tritium. The detection on the filter paper of more than 2,200 disintegrations per minute of tritium per 100 square centimeters of surface wiped or in the water of more than 0.1 percent of the original amount of tritium in any device shall be cause for rejection of the tested device.

(vi) A person licensed under this section to manufacture, assemble or import devices containing tritium for distribution to persons generally licensed under

§ 30.21(d) shall affix to each device a label which shall include the manufacturer's or importer's license number, the radiation symbol prescribed by § 20.203 (f) of this chapter, a statement that the device contains tritium and is generally licensed by the USAEC pursuant to § 30.21(d), and such other information as may be required by the Commission, including disposal instructions when appropriate. If the Commission determines that labeling on the device is not feasible and that an unreasonable risk to the health and safety of the public will not be created, it may dispense with the labeling of the device on condition that a leaflet bearing the prescribed information is enclosed in the container in which the device is shipped.

(2) (i) Each person licensed under this paragraph shall visually inspect each device and shall reject any which has an observable physical defect that could affect containment of the tritium.

(ii) Each person licensed under this paragraph shall subject a number of devices from each production lot sampled in accordance with § 30.25, to the following quality control procedures:

(a) Each device shall be immersed in 30 inches of water for 24 hours and shall show no visible evidence of water entry. Absolute pressure of the air above the water shall then be reduced to 1 inch of mercury. Lowered pressure shall be maintained for 1 minute or until air bubbles cease to be given off by the water, whichever is the longer. Pressure shall then be increased to normal atmospheric pressure. Any device which leaks as evidenced by bubbles emanating from within the device, or water entering the device, shall be rejected.

(b) The immersion test water from the preceding test (a) of this subdivision shall be measured for tritium content by an apparatus that has been calibrated to measure tritium. If more than 0.1 percent of the original amount of tritium in any device is found to have leaked into the immersion test water, the leaking device shall be rejected.

(iii) An application for a license or for amendment of a license may include a description of quality control procedures proposed as alternatives to those prescribed by subdivision (ii) of this subparagraph and proposed criteria for acceptance under those procedures. The Commission will approve the proposed alternative procedures if the applicant demonstrates that they will assure the rejection of any device which has a leakage rate exceeding 0.1 percent of the original quantity of tritium in any 24-hour period.

(iv) No person licensed under this paragraph shall transfer to persons generally licensed under § 30.21(d) any luminous safety device which has been tested and rejected under the criteria and procedures specified in this subparagraph (2).

(3) Each person licensed under this paragraph shall file an annual report with the Director, Division of Licensing and Regulation, which shall state the total quantity of tritium transferred to persons generally licensed under § 30.21 (d). The report shall identify each general licensee by name, state the kinds and numbers of luminous devices transferred, and specify the quantity of tritium in each kind of device. Each report shall cover the year ending June 30 and shall be filed within thirty (30) days thereafter.

[Added]

Source: § 30.24(j) appears at 27 F.R. 2394, Mar. 14, 1962.

(k)—[Reserved]

(l)—[Reserved]

(m) *Certain automobile lock illuminators.* (1) An application for a specific license to install lock illuminators into automobile locks, or to import for sale or distribution lock illuminators installed in automobile locks for use pursuant to § 30.12 will be approved if:

(i) The applicant satisfies the general requirements specified in § 30.33.

(ii) The applicant submits sufficient information regarding the lock illuminators pertinent to evaluation of the potential radiation exposure, including:

(a) Chemical and physical form and maximum quantity of tritium in each lock illuminator;

(b) Details of construction and design of the lock illuminator;

(c) Details of the method of binding or containing the tritium;

(d) Details of the method of installing the lock illuminators into the automobile lock so that the lock illuminator is not readily removable from the automobile lock;

(e) Procedures for and results of prototype testing to demonstrate that the lock illuminator will not become detached from the lock and the tritium will not be released to the environment under the most severe conditions likely to be encountered in normal use of the lock illuminator;

(f) Quality control procedures to demonstrate that production lots of the lock illuminators will meet the specifications established by the Commission for such lock illuminators;

(g) Any additional information, including experimental studies and tests, required by the Commission to facilitate determination of the safety of the lock illuminator.

(iii) Each lock illuminator will contain no more than 15 millicuries of tritium;

(iv) The Commission determines that

(a) The tritium is bound in the luminous compound in a nonwater soluble and nonlabile form and the compound is incorporated and bound in the lock illuminator [illegible] tritium will not be released under the most severe conditions which are likely to be encountered in normal use and handling;

(b) The tritium in the [illegible] lock illuminator so as to [illegible] direct physical contact by any person with the tritium;

(c) The method of [illegible] the lock illuminator into the [illegible] such that the lock illuminator will not become detached from the lock under the most severe conditions which are likely to be encountered in normal use and handling;

(d) The device consisting of the automobile lock with the installed lock illuminator has been subjected to the prototype tests and meets the requirements prescribed by subdivision (v) of this subparagraph;

(v) The prototype tests shall include the following, to be conducted on each of five prototype devices in the following order:

(a) The device shall be subjected to 100 hours of accelerated weathering in a suitable weathering machine which simulates the most severe conditions of normal use;

(b) The device shall be dropped upon a concrete or iron surface in a 3-foot free gravitational fall, or shall be subjected to an equivalent treatment in a test device simulating such a fall. The drop test shall be repeated 100 times from random orientations;

(c) The device shall be attached to a vibratory fixture and vibrated at a rate of not less than 26 cycles per second and a vibration acceleration of not less than 2 G for a period of not less than 1 hour;

(d) On completion of the foregoing tests the device shall be immersed in 30 inches of water for 24 hours and shall show no visible evidence of water entry into the lock illuminator. Absolute pressure of the air above the water shall then be reduced to 1 inch of mercury. Lowered pressure shall be maintained for 1 minute or until air bubbles cease to be given off by the water whichever is the longer. Pressure shall then be increased to normal atmospheric pressure. Any evidence of bubbles emanating from within the lock illuminator, or water entering the lock illuminator, shall be considered leakage.

(e) After each of the tests prescribed by this § 30.24 (m)(1)(v), each device shall be examined for evidence of physical damage and for loss of tritium. Any evidence of damage to or failure of any device which could affect the containment of the tritium in such devices shall be cause for rejection of the design on which such prototype devices were constructed or manufactured if the damage or failure is attributable to design defect. Loss of tritium from each tested device shall be measured both by sampling the immersion test water used in (d) of this subdivision and by wiping with filter paper the entire accessible area of the lock illuminator. Measurements of tritium shall be made in an apparatus calibrated to measure tritium [illegible] 0.1 percent of the original amount of tritium in the device is found in the immersion test water of test (d) of this subdivision or if more than 2,200 disintegrations per minute of tritium on the filter paper is measured after any of the tests in (a) to (d) of this subdivision the device shall be rejected.

(2) Each person licensed under this paragraph shall

(i) Maintain records showing [illegible] manufacture of lock illuminators of this

installation of lock illuminators into automobile locks;

(ii) Subject production lots to such quality control tests as may be required as a condition of the license issued under this paragraph, sampled in accordance with § 30.25; and

(iii) Visually inspect each device in production lots and reject any device which has an observable physical defect that could affect containment of the tritium.

(3) Each person licensed under this paragraph shall file an annual report with the Director, Division of Licensing and Regulation, which shall state the total quantity of tritium transferred to other persons under § 30.12, during the reporting period, in the form of lock illuminators contained in automobile locks. Such report shall identify by name and address all persons to whom a total of more than 5 curies of tritium were distributed under § 30.12 during the reporting period. Each report shall cover the year ending June 30 and shall be filed within 30 days thereafter.

[Added]

SOURCE: § 30.24(m) appears at 27 F R 3123, Mar. 31, 1962.

§ 30.25 *Quality control sampling procedures under certain specific licenses.* (a) Each production lot of devices licensed under paragraph (i), (j), or (m) of § 30.24 shall be sampled in accordance with Sampling Table A. If the permissible number of rejects specified in Sampling Table A for a lot of that size is exceeded, all devices in that lot shall be sampled or the entire lot rejected. If ten (10) or more successive lots have been tested and none of them includes a larger number of rejects than specified in Sampling Table A, the succeeding lots may be sampled in accordance with Sampling Table B.

[Amended]

CHANGE: First sentence of § 30.25(a) amended to read as set forth above at 27 F R 3124, Mar. 31, 1962.

(b) If any lot sampled in accordance with Sampling Table B includes a larger number of rejects than specified in Sampling Table B for a lot of that size, all devices in that lot shall be sampled or the entire lot rejected. Succeeding lots shall be sampled in accordance with the provisions of paragraph (a) of this section.

[Added]

SOURCE: § 30.25 appears at 27 F R 2396 Mar. 14, 1962.

SAMPLING TABLE A

Lot size	Sample size	Permissible number of rejects
Less than 6	All	0
6-150	6	0
151-280	7	0
281-500	10	1
501-800	15	1
801-1,300	22	2
1,301-3,200	30	2
3,201-8,000	45	3
8,001-22,000	60	4

SAMPLING TABLE B

Lot size	Sample size	Permissible number of rejects
Less than 6	All	0
6-150	3	0
151-280	6	0
281-500	7	1
501-800	10	1
801-1,300	15	1
1,301-3,200	22	2
3,201-8,000	30	2
8,001-22,000	45	3
22,001 and over	60	4

LICENSES

§ 30.31 *Issuance of specific licenses for use of byproduct material.* (a) Upon a determination that an application meets the requirements of the act and the regulations of the Commission, the Commission will issue a specific license authorizing the possession and use of byproduct material (Form AEC 374, "Byproduct Material License").

(b) The Commission may incorporate in any license at the time of issuance, or thereafter by appropriate rule, regulation or order, such additional requirements and conditions with respect to the licensee's receipt, possession, use and transfer of byproduct material as it deems appropriate or necessary in order to:

(1) Promote the common defense and security;

(2) Protect health or to minimize danger to life or property;

(3) Protect restricted data;

(4) Require such reports and the keeping of such records, and to provide for such inspections of activities under the license as may be necessary or appropriate to effectuate the purposes of the act and regulations thereunder.

§ 30.32 *Terms and conditions of licenses.* (a) Each license issued pursuant to the regulations in this part shall be subject to all the provisions of the act, now or hereafter in effect, and to all valid rules, regulations and orders of the Commission.

(b) Neither the license nor any right under the license shall be assigned or otherwise transferred in violation of the provisions of the act.

(c) Each person licensed by the Commission pursuant to the regulations in this part shall confine his possession and use of byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license a license issued pursuant to the regulations in this part shall carry with it the right to receive, acquire, own, possess and import byproduct material and to transfer such material to other licensees within the United States authorized to receive such material.

(d) Each license issued pursuant to the regulations in this part shall be deemed to contain the provisions set forth in section 183a-d, inclusive, of the act, whether or not said provisions are expressly set forth in the license.

(e) Each licensee authorized under § 30.24(f) to distribute certain devices to generally licensed persons:

(1) Shall report to the Director, Division of Licensing and Regulation all transfers of such devices to persons generally licensed under § 30.21(c). Such report shall identify each general licensee by name and address, the type of device transferred, and the quantity and type of byproduct material contained in the device. The report shall be submitted within 30 days after the end of each calendar quarter in which such a device is transferred to generally licensed persons; and

(2) Shall furnish to each general licensee to whom he transfers such device a copy of the general license contained in § 20.21(c).

[Added]

SOURCE: § 30.32(e) appears at 24 F R 1090, Feb. 12, 1959.

(f) Notwithstanding the provisions of §§ 30.9 and 30.32(c) of this part, no person licensed by the Commission pursuant to the regulations in this part shall transfer possession or control of any product or material containing concentrations of byproduct material not exceeding those specified in § 30.73 which he has introduced into the product or material unless the transferor has received a license from the Commission pursuant to § 30.24(h) authorizing such transfer. The provisions of this paragraph (f) shall not apply to transfers to duly licensed persons of products or materials containing byproduct material for analytical, laboratory, or waste disposal purposes. This paragraph shall not be deemed to modify any authority granted to any person in a specific license issued by the Commission prior to the effective date of this paragraph.

[Added]

SOURCE: § 30.32(f) appears at 25 F.R. 7875, Aug. 17, 1960.

§ 30.33 *Exports of byproduct material.* (a) No licensee shall export byproduct material from the United States except as authorized pursuant to this section.

(b) Any licensee may export byproduct material covered by his license to any foreign country except Cuba or countries or areas now or hereafter listed as Subgroup A countries or destinations in § 371.3 of the Comprehensive Export Schedule of the United States Department of Commerce (15 CFR 371.3): *Provided*, That the authority conferred by this paragraph shall apply only to byproduct material having an atomic number from 3 to 83, inclusive, and to tritium when contained in luminous safety devices installed in aircraft and distributed as generally licensed items pursuant to § 30.24(j).

[Amended]

CHANGE: § 30.33 b amended by adding the words "Cuba or" after the phrase "to any foreign country except" at 26 F R 7825 Aug. 23, 1961 and amended to read as set forth above at 27 F R 2396 Mar. 14, 1962.

(c) Any licensee may export byproduct material covered by his license to Cuba to the extent that the byproduct material is contained in medicinals or pharmaceutical preparations or in devices, applicators, or appliances designed for use in medical diagnosis or therapy: *Provided*, That the authority conferred

by this paragraph shall apply only to byproduct material having an atomic number from 3 to 83, inclusive.

[Amended]

CHANGE: § 30.33(c) amended to read as set forth above at 26 F.R. 7825, Aug. 23, 1961.

(d) A general license is hereby issued authorizing any person to export from the United States to any countries or destinations not listed in § 30.75 *Schedule E*, 5,000 curies of tritium and 5,000 curies of polonium 210 in a calendar quarter. Not more than 1,000 curies of tritium may be exported by any person to any one country or destination in a calendar quarter and not more than 100 curies of tritium may be exported by any person in a single shipment under this general license. Exports under this general license may be in one or more of the following forms or products only:

(1) Tritium activated luminous paint;
(2) Tritium labeled organic compounds;
(3) Tritiated accelerator targets;
(4) Polonium 210 static eliminators;
(5) Polonium 210 neutron sources;
(6) Tritium or polonium 210 calibration standards;
(7) Luminescent light sources;
(8) Tritium sources for chromatography instruments;
(9) Electron tubes; or
(10) Tritium as a contaminant of Helium 3 in a concentration not to exceed 2.5 millicuries of tritium per liter of Helium 3.[1]

[Amended]

CHANGE: § 30.33(d) amended at 27 F.R. 7825, Aug. 23, 1961 and deleted at 27 F.R. 12257, Dec. 12, 1962.

[Added]

SOURCE: New paragraphs (d) to (f) added to § 30.33 at 27 F.R. 12257, Dec. 12, 1962.

(e) The Commission may, upon application by an interested person, issue a license authorizing the export of byproduct material to a country or destination listed in § 30.75 *Schedule E*, or the export of byproduct material in quantities or forms not authorized for export under general license if, in the opinion of the Commission, the proposed export would not be inimical to the common defense and security.

(f) A person exporting byproduct material pursuant to the general license established by paragraph (d) of this section, shall file with the Collector of Customs, or the Postmaster, one copy, in addition to those otherwise required, of the Shipper's Export Declaration, covering each export, marked for transmittal to the Division of Licensing and Regulation of the United States Atomic Energy Commission, Washington 25, D.C. In addition to such other information as may be required, the following information shall be included in the Shipper's Export Declaration: Identification of the byproduct material; the quantity in curies; and the ratio of tritium to the total quantity of hydrogen if the material is tritium-activated luminous paint.

[Added]

SOURCE: § 30.33(e) appears at 27 F.R. 8173, Aug. 16, 1962 and at 27 F.R. 12257, Dec. 12, 1962.

(h) No person may export byproduct material from the United States knowing or having reason to believe that it is to be reexported directly or indirectly, in whole or in part, from the country of ultimate destination shown on the export license, shipper's export declaration, bill of lading, or commercial invoice, unless either:

(1) The reexport has been authorized by the Commission; or

(2) At the time of export, the material may be exported directly from the United States to the new country of ultimate destination under the terms of one of the general licenses established in this section.

[Amended]

CHANGE: Paragraph (e) of § 30.33 redesignated as paragraph (h) at 27 F.R. 12257, Dec. 12, 1962.

§ 30.34 *Expiration.* Except as provided in § 30.35 (b), each specific license shall expire at the end of the day, in the month and year stated therein.

§ 30.35 *Renewal of license.* (a) Applications for renewal of a specific license shall be filed in accordance with § 30.22.

(b) In any case in which a licensee, not less than thirty (30) days prior to expiration of his existing license, has filed an application in proper form for renewal or for a new license, such existing license shall not expire until the application for a renewal has been finally determined by the Commission.

§ 30.36 *Amendment of licenses at request of licensee.* Applications for amendment of a license shall be filed in accordance with § 30.22 and shall specify the respects in which the licensee desires his license to be amended and the grounds for such amendment.

§ 30.37 *Commission action on applications to renew or amend.* In considering an application by a licensee to renew or amend his license the Commission will apply the applicable criteria set forth in §§ 30.23 and 30.24.

§ 30.39 *Inalienability of licenses.* No license issued or granted pursuant to the regulations in this part shall be transferred, assigned or in any manner disposed of, either voluntarily or involuntarily, directly or indirectly, through transfer of control of any license to any person, unless the Commission shall, after securing full information, find that the transfer is in accordance with the provisions of this act, and shall give its consent in writing.

§ 30.40 *Persons possessing byproduct material on effective date of regulations in this part.* (a) Any person who on the effective date of the regulations in this part possesses byproduct material pursuant to an authorization heretofore issued by the Commission shall be deemed to possess such material pursuant to a license issued under the regulations in this part which shall expire ninety days after receipt from the Commission of a notice of expiration of such license. Such license shall be deemed to include all terms and conditions incorporated in such authorization which are not inconsistent with or otherwise provided for in the regulations in this part.

(b) Any authorization heretofore issued pursuant to the regulations in this part shall be deemed to be a valid license during the period prior to the expiration date set forth in said authorization. Such license shall be deemed to include all terms and conditions incorporated in such authorization which are not inconsistent with or otherwise provided for in the regulations in this part.

RECORDS, REPORTS AND INSPECTIONS

§ 30.41 *Records.* (a) Each person who receives byproduct material pursuant to a license issued pursuant to the regulations in this part shall keep records showing the receipt, transfer, export and disposal of such byproduct material.

[Revocation]

SOURCE: § 30.42 revoked at 27 F.R. 12257, Dec. 12, 1962.

§ 30.43 *Inspection.* (a) Each licensee shall afford to the Commission at all reasonable times opportunity to inspect byproduct material and the premises and facilities wherein byproduct material is used or stored.

(b) Each licensee shall make available to the Commission for inspection, upon reasonable notice, records kept by him pursuant to the regulations in this chapter.

§ 30.44 *Tests.* Each licensee shall perform, or permit the Commission to perform, such tests as the Commission deems appropriate or necessary for the administration of the regulations in this part, including tests of:

(a) Byproduct material,
(b) Facilities wherein byproduct material is utilized or stored,
(c) Radiation detection and monitoring instruments, and
(d) Other equipment and devices used in connection with the utilization or storage of byproduct material.

MODIFICATION AND REVOCATION OF LICENSES

§ 30.51 *Modification and revocation of licenses.* (a) The terms and conditions of each license shall be subject to amendment, revision or modification by reason of amendments to the act, or by reason of rules, regulations and orders issued in accordance with the terms of the act.

(b) Any license may be revoked, suspended or modified, in whole or in part, for any material false statement in the application or any statement of fact required under section 182 of the act, or because of conditions revealed by such application or statement of fact or any report, record or inspection or other

[1] Export shipments of Helium gas are subject to the licensing authority and regulations of the Department of State. Issuance of a specific or general license by the Commission for tritium contained in Helium 3 does not relieve any person from complying with the licensing requirements and regulations of the Department of State applicable to the export of Helium 3.

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means which would warrant the Commission to refuse to grant a license on an original application, or for violation of, or failure to observe any of the terms and provisions of the act or of any rule, regulation or order of the Commission.

(c) Except in cases of willfulness or those in which the public health, interest or safety requires otherwise, no license shall be modified, suspended or revoked unless, prior to the institution of proceedings therefor, facts or conduct which may warrant such action shall have been called to the attention of the licensee in writing and the licensee shall have been accorded an opportunity to demonstrate or achieve compliance with all lawful requirements.

§ 30.52 *Right to withhold or recall byproduct material.* The Commission may withhold, recall or order the withholding or recall of byproduct material from any licensee who is not equipped to observe or fails to observe such safety standards to protect health as may be established by the Commission, or who uses such materials in violation of law or regulation of the Commission, or in a manner other than as disclosed in the application therefor or approved by the Commission.

ENFORCEMENT

§ 30.61 *Violations.* An injunction or other court order may be obtained prohibiting any violation of any provision of the act or any regulation or order issued thereunder. Any person who willfully violates any provision of the act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

SCHEDULES

§ 30.71 *Schedule A.* The following devices and equipment incorporating byproduct material, when manufactured, tested and labeled by the manufacturer in accordance with the specifications contained in a specific license issued to him pursuant to the regulations in this part, are placed under a general license pursuant to § 30.21 (a) (1).

(a) *Static elimination device.* Devices designed for use as static eliminators which contain, as a sealed source or sources, byproduct material consisting of a total of not more than 500 microcuries of Polonium 210 per device.

(b) *Spark gap and electronic tubes.* Spark gap tubes and electronic tubes which contain byproduct material consisting of not more than 5 microcuries per tube of Cesium 137, or Nickel 63, or Krypton 85 gas, or not more than one microcurie per tube of Cobalt 60.

(c) *Light meter.* Devices designed for use in measuring or determining light intensity which contain, as a sealed source or sources, byproduct material consisting of a total of not more than

200 microcuries of Strontium 90 per device.

(d) *Ion generating tube.* Devices designed for ionization of air which contain, as a sealed source or sources, byproduct material consisting of a total of not more than 500 microcuries of Polonium 210 per device or of a total of not more than 50 millicuries of Hydrogen 3 (tritium) per device.

[Amended]

CHANGE: § 30.71 Schedule A (a) through (d) amended at 21 F.R. 7505, Oct. 3, 1956. § 30.71 (d) revised at 22 F.R. 8219, Oct. 17, 1957

§ 30.72 *Schedule B.* The following quantities of byproduct material are generally licensed pursuant to § 30.21 (a) (2).

Byproduct material	Column No. I — Not as a sealed source (microcuries)	Column No. II — As a sealed source (microcuries)
Antimony 124 (Sb 124)	1	10
Arsenic 76 (As 76)	10	10
Arsenic 77 (As 77)	10	10
Barium 140—Lanthanum 140 (BaLa 140)	1	10
Beryllium 7 (Be 7)	50	50
Cadmium 109—Silver 109 (CdAg 109)	10	10
Calcium 45 (Ca 45)	10	10
Carbon 14 (C 14)	50	50
Cerium 144—Praseodymium 144 (CePr 144)	1	10
Cesium-Barium 137 (CsBa 137)	1	10
Chlorine 36 (Cl 36)	1	10
Chromium 51 (Cr 51)	50	50
Cobalt 60 (Co 60)	1	10
Copper 64 (Cu 64)	50	50
Europium 154 (Eu 154)	1	10
Fluorine 18	50	50
Gallium 72 (Ga 72)	10	10
Germanium 71 (Ge 71)	50	50
Gold 198 (Au 198)	10	10
Gold 199 (Au 199)	10	10
Hydrogen 3 (Tritium) (H 3)	250	250
Indium 114 (In 114)	1	10
Iodine 131 (I 131)	10	10
Iridium 192 (Ir 192)	10	10
Iron 55 (Fe 55)	50	50
Iron 59 (Fe 59)	1	10
Lanthanum 140 (La 140)	10	10
Manganese 52 (Mn 52)	1	10
Manganese 56 (Mn 56)	50	50
Molybdenum 99 (Mo 99)	10	10
Nickel 59 (Ni 59)	1	10
Nickel 63 (Ni 63)	1	10
Niobium 95 (Nb 95)	10	10
Palladium 109 (Pd 109)	10	10
Palladium 103—Rhodium 103 (PdRh 103)	50	50
Phosphorus 32 (P 32)	10	10
Polonium 210 (Po 210)	0.1	1
Potassium 42 (K 42)	10	10
Praseodymium 143 (Pr 143)	10	10
Promethium 147 (Pm 147)	10	10
Rhenium 186 (Re 186)	10	10
Rhodium 105 (Rh 105)	10	10
Rubidium 86 (Rb 86)	10	10
Ruthenium 106—Rhodium 106 (RuRh 106)	1	10
Samarium 153 (Sm 153)	10	10
Scandium 46 (Sc 46)	1	10
Silver 105 (Ag 105)	1	10
Silver 111 (Ag 111)	10	10
Sodium 22 (Na 22)	10	10
Sodium 24 (Na 24)	10	10
Strontium 89 (Sr 89)	1	10
Strontium 90—Yttrium 90 (SrY 90)	0.1	1
Sulfur 35 (S 35)	50	50
Tantalum 182 (Ta 182)	[illegible]	[illegible]
[illegible]	1	[illegible]
Technetium 96 (Tc 96)	1	10
Tellurium 127 (Te 127)	10	10
Tellurium 129 (Te 129)	1	10
Thallium 204 (Tl 204)	50	50
Tin 113 (Sn 113)	10	10
Tungsten 185 (W 185)	10	10
Vanadium 48 (V 48)	1	10
Yttrium 90 (Y 90)	1	10
Yttrium 91 (Y 91)	1	10
Zinc 65 (Zn 65)	10	10
Beta and/or Gamma emitting byproduct material not listed above	1	10

[Amended]

CHANGE: Correction of abbreviation of Cesium Barium 137 to (CsBa 137); and the added portion of table following "Zinc 65" was added at 21 F.R. 7505, Oct. 3, 1956.

NOTE: The reporting and record-keeping requirements contained herein have been approved by the Bureau of the Budget in accordance with The Federal Reports Act of 1942

§ 30.73 Schedule C.

Element (atomic number)	Isotope	Column I — Gas concentration (μc/ml)[1]	Column II — Liquid and solid concentration (μc/ml)[2]
Antimony (51)	Sb 122	....	3×10^{-4}
	Sb 124	....	2×10^{-4}
	Sb 125	....	1×10^{-3}
Argon (18)	A 37	1×10^{-3}	....
	A 41	4×10^{-7}	....
Arsenic (33)	As 73	....	5×10^{-3}
	As 74	....	5×10^{-4}
	As 76	....	2×10^{-4}
	As 77	....	8×10^{-4}
Barium (56)	Ba 131	....	2×10^{-3}
	Ba 140	....	3×10^{-4}
Beryllium (4)	Be 7	....	2×10^{-2}
Bismuth (83)	Bi 206	....	4×10^{-4}
Bromine (35)	Br 82	4×10^{-7}	3×10^{-3}
Cadmium (48)	Cd 109	....	2×10^{-3}
	Cd 115m	....	3×10^{-4}
	Cd 115	....	3×10^{-4}
Calcium (20)	Ca 45	....	9×10^{-5}
	Ca 47	....	5×10^{-4}
Carbon (6)	C 14	1×10^{-6}	8×10^{-3}
Cerium (58)	Ce 141	....	9×10^{-4}
	Ce 143	....	4×10^{-4}
	Ce 144	....	1×10^{-4}
Cesium (55)	Cs 131	....	2×10^{-2}
	Cs 134m	....	6×10^{-2}
	Cs 134	....	9×10^{-5}
Chlorine (17)	Cl 38	9×10^{-7}	4×10^{-3}
Chromium (24)	Cr 51	....	2×10^{-2}
Cobalt (27)	Co 57	....	5×10^{-3}
	Co 58	....	1×10^{-3}
	Co 60	....	5×10^{-4}
Copper (29)	Cu 64	....	3×10^{-3}
Dysprosium (66)	Dy 165	....	4×10^{-3}
	Dy 166	....	4×10^{-4}
Erbium (68)	Er 169	....	9×10^{-4}
	Er 171	....	1×10^{-3}
Europium (63)	Eu 152 (T/2=9.2 Hrs)	....	6×10^{-4}
	Eu 155	....	2×10^{-3}
Fluorine (9)	F 18	2×10^{-6}	8×10^{-3}
Gadolinium (64)	Gd 153	....	2×10^{-3}
	Gd 159	....	8×10^{-4}
Gallium (31)	Ga 72	....	4×10^{-4}
Germanium (32)	Ge 71	....	2×10^{-2}
Gold (79)	Au 196	....	2×10^{-3}
	Au 198	....	5×10^{-4}
	Au 199	....	2×10^{-3}
Hafnium (72)	Hf 181	....	7×10^{-4}
Hydrogen (1)	H 3	5×10^{-6}	3×10^{-2}
Indium (49)	In 113m	....	1×10^{-2}
	In 114m	....	2×10^{-4}
Iodine (53)	I 126	3×10^{-9}	2×10^{-5}
	I 131	3×10^{-9}	2×10^{-5}
	I 132	8×10^{-8}	6×10^{-4}
	I 133	1×10^{-8}	7×10^{-5}
	I 134	2×10^{-7}	1×10^{-3}
Iridium (77)	Ir 190	....	2×10^{-3}
	Ir 192	....	4×10^{-4}
	Ir 194	....	3×10^{-4}
Iron (26)	Fe 55	....	8×10^{-3}
	Fe 59	....	6×10^{-4}
Krypton (36)	Kr 85m	1×10^{-6}	....
	Kr 85	3×10^{-6}	....
Lanthanum (57)	La 140	....	2×10^{-4}
Lead (82)	Pb 203	....	4×10^{-3}
Lutetium (71)	Lu 177	....	1×10^{-3}
Manganese (25)	Mn 52	....	3×10^{-4}
	Mn 54	....	[illegible]
	Mn 56	....	[illegible]
[illegible]	[illegible]	....	[illegible]
Molybdenum (42)	Mo 99	....	[illegible]
Neodymium (60)	Nd 147	....	[illegible]
	Nd 149	....	[illegible]
Nickel (28)	Ni 65	....	[illegible]
Niobium (Columbium) (41)	Nb 95	....	[illegible]
	Nb 97	....	[illegible]
Osmium (76)	Os 185	....	[illegible]
	[illegible]	....	3×10^{-3}
	[illegible]	....	[illegible]
	[illegible]	....	[illegible]
Palladium (46)	Pd 103	....	[illegible]
	Pd 109	....	[illegible]
Phosphorus (15)	P 32	....	[illegible]
Platinum (78)	Pt 191	....	1×10^{-3}
	Pt 193m	....	1×10^{-2}
	Pt 197m	....	1×10^{-2}
	Pt 197	....	1×10^{-3}
Potassium (19)	K 42	....	3×10^{-3}
Praseodymium (59)	Pr 142	....	3×10^{-4}
	Pr 143	....	5×10^{-4}
Promethium (61)	Pm 147	....	2×10^{-3}
	Pm 149	....	4×10^{-4}
Rhenium (75)	Re 183	....	6×10^{-3}
	Re 186	....	9×10^{-4}
	Re 188	....	6×10^{-4}
Rhodium (45)	Rh 103m	....	1×10^{-1}
	Rh 105	....	1×10^{-3}
Rubidium (37)	Rb 86	....	7×10^{-4}
Ruthenium (44)	Ru 97	....	4×10^{-3}
	Ru 103	....	8×10^{-4}
	Ru 105	....	1×10^{-3}
	Ru 106	....	1×10^{-4}
Samarium (62)	Sm 153	....	8×10^{-4}
Scandium (21)	Sc 46	....	4×10^{-4}
	Sc 47	....	9×10^{-4}
	Sc 48	....	3×10^{-4}
Selenium (34)	Se 75	....	3×10^{-3}
Silicon (14)	Si 31	....	9×10^{-3}
Silver (47)	Ag 105	....	1×10^{-3}
	Ag 110m	....	3×10^{-4}
	Ag 111	....	4×10^{-4}
Sodium (11)	Na 24	....	2×10^{-3}
Strontium (38)	Sr 85	....	1×10^{-3}
	Sr 91	....	[illegible]
	Sr 92	....	7×10^{-4}
Sulfur (16)	S 35	9×10^{-8}	6×10^{-4}
Tantalum (73)	Ta 182	....	4×10^{-4}
Technetium (43)	Tc 96m	....	1×10^{-1}
	Tc 96	....	1×10^{-3}
Tellurium (52)	Te 125m	....	2×10^{-3}
	Te 127m	....	6×10^{-4}
	Te 127	....	3×10^{-3}
	Te 129m	....	3×10^{-4}
	Te 131m	....	6×10^{-4}
	Te 132	....	3×10^{-4}
Terbium (65)	Tb 160	....	4×10^{-4}
Thallium (81)	Tl 200	....	4×10^{-3}
	Tl 201	....	3×10^{-3}
	Tl 202	....	1×10^{-3}
	Tl 204	....	1×10^{-3}
Thulium (69)	Tm 170	....	5×10^{-4}
	Tm 171	....	5×10^{-3}
Tin (50)	Sn 113	....	9×10^{-4}
	Sn 125	....	2×10^{-4}
Tungsten (Wolfram) (74)	W 181	....	4×10^{-3}
	W 187	....	7×10^{-4}
Vanadium (23)	V 48	....	3×10^{-4}
Xenon (54)	Xe 131m	4×10^{-6}	....
	Xe 133	3×10^{-6}	....
	Xe 135	1×10^{-6}	....
Ytterbium (70)	Yb 175	....	1×10^{-3}
Yttrium (39)	Y 90	....	2×10^{-4}
	Y 91m	....	3×10^{-2}
	Y 91	....	3×10^{-4}
	Y 92	....	6×10^{-4}
	Y 93	....	3×10^{-4}
Zinc (30)	Zn 65	....	1×10^{-3}
	Zn 69m	....	[illegible]
	Zn 69	....	[illegible]
Zirconium (40)	Zr 95	....	[illegible]
	Zr 97	....	[illegible]
Beta and/or gamma emitting byproduct material not listed above with half-life less than 3 years.	....	1×10^{-10}	1×10^{-6}

NOTE 1: Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing the concentrations in Schedule C the activity stated is that of the parent isotope and takes into account the daughters.

NOTE 2: For purposes of § 30.70 where there is involved a combination of isotopes, the limit for the combination should be derived as follows: Determine for each isotope in the product the ratio between the concentration present in the product and the concentration specified in Schedule C for [illegible] [illegible]

[illegible]

$$\frac{\text{Concentration of Isotope A in Product}}{\text{Exempt concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in Product}}{\text{Exempt concentration of Isotope B}} \leq 1$$

[1] Values are given only for those materials normally used as gases.

[2] μc/gm for solids.

[Added]

SOURCE: § 30.73 appears at 25 F.R. 7876, Aug. 17, 1960

§ 30.75 *Schedule E.*

Albania.
Bulgaria.
China, including Manchuria and excluding Taiwan (Formosa)) (includes Inner Mongolia; the provinces of Tsinghai and Sikang; Sinkiang; Tibet; the former Kwantung Leased Territory, the present Port Arthur Naval Base Area and Liaoning Province).
Communist-controlled area of Viet Nam.
Cuba.
Czechoslovakia.
East Germany (Soviet Zone of Germany and the Soviet Sector of Berlin.)
Estonia.
Hungary.
Latvia.
Lithuania.
North Korea.
Outer Mongolia.
Poland.
Rumania.
Union of Soviet Socialist Republics.

[Added]

SOURCE: § 30.75 appears at 27 F.R. 12257, Dec. 12, 1962.